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Wood

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(54) MULTI-CONFIGURATION MINI JIG

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(72) Inventor: **Sidney A Wood**, Wasilla, AK (US)

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B03B 5/16 (2006.01)
B03B 5/24 (2006.01)

(52) **U.S. Cl.**
CPC . ***B03B 5/16*** (2013.01); ***B03B 5/24*** (2013.01)

(58) **Field of Classification Search**
CPC B03B 5/16; B03B 5/10; B03B 5/24
USPC 209/269
See application file for complete search history.

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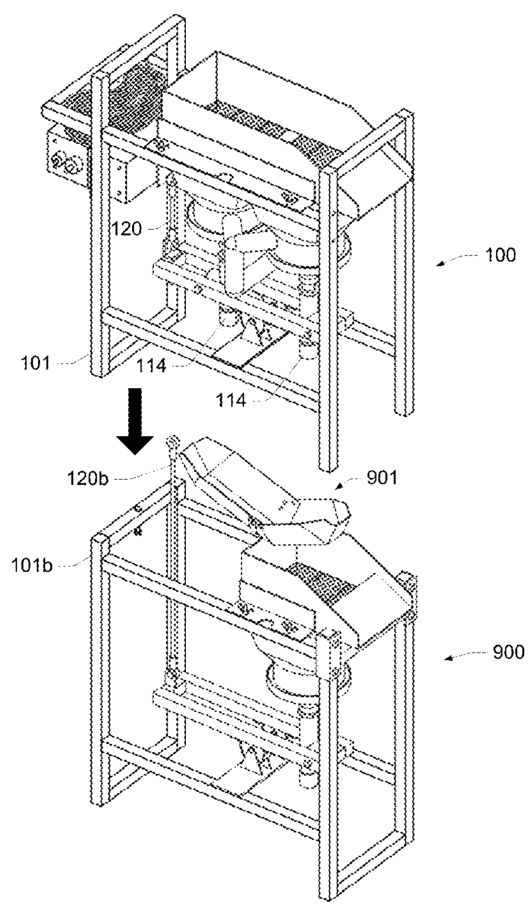
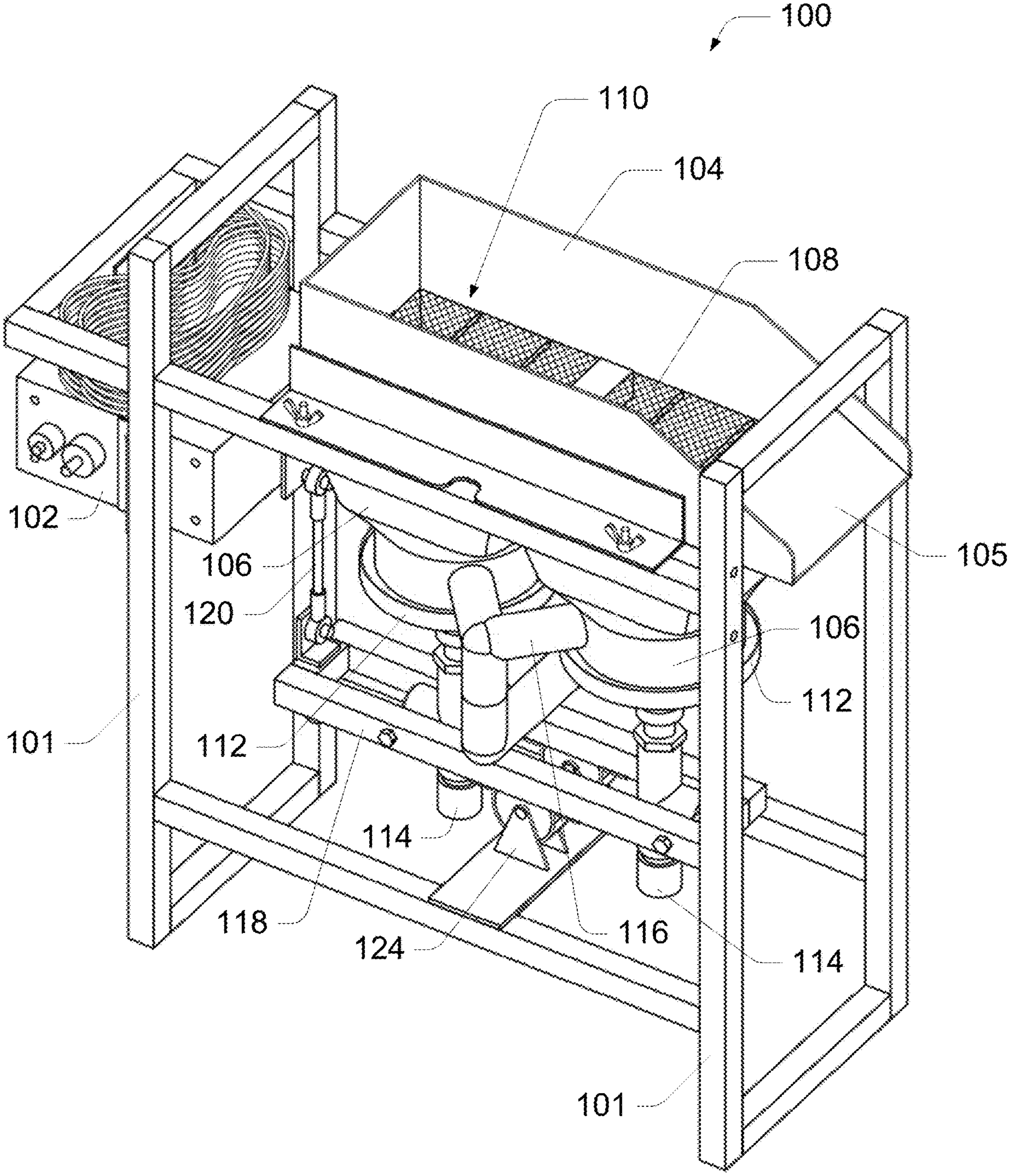
Primary Examiner — Michael McCullough
Assistant Examiner — Jessica L Burkman

(57) **ABSTRACT**

A portable, modular mini mining jig can be configured as a single-stage jig with one or multiple jig cells, or as a multistage jig with one or multiple jig cells per stage. Due to the modular nature of the mini jig components, any number of jig cells and stages are possible. Adding jig cells and stages increases the throughput and capacity of the system, which increases efficiency.

20 Claims, 19 Drawing Sheets

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114
118
124
116
114
101

FIG. 1

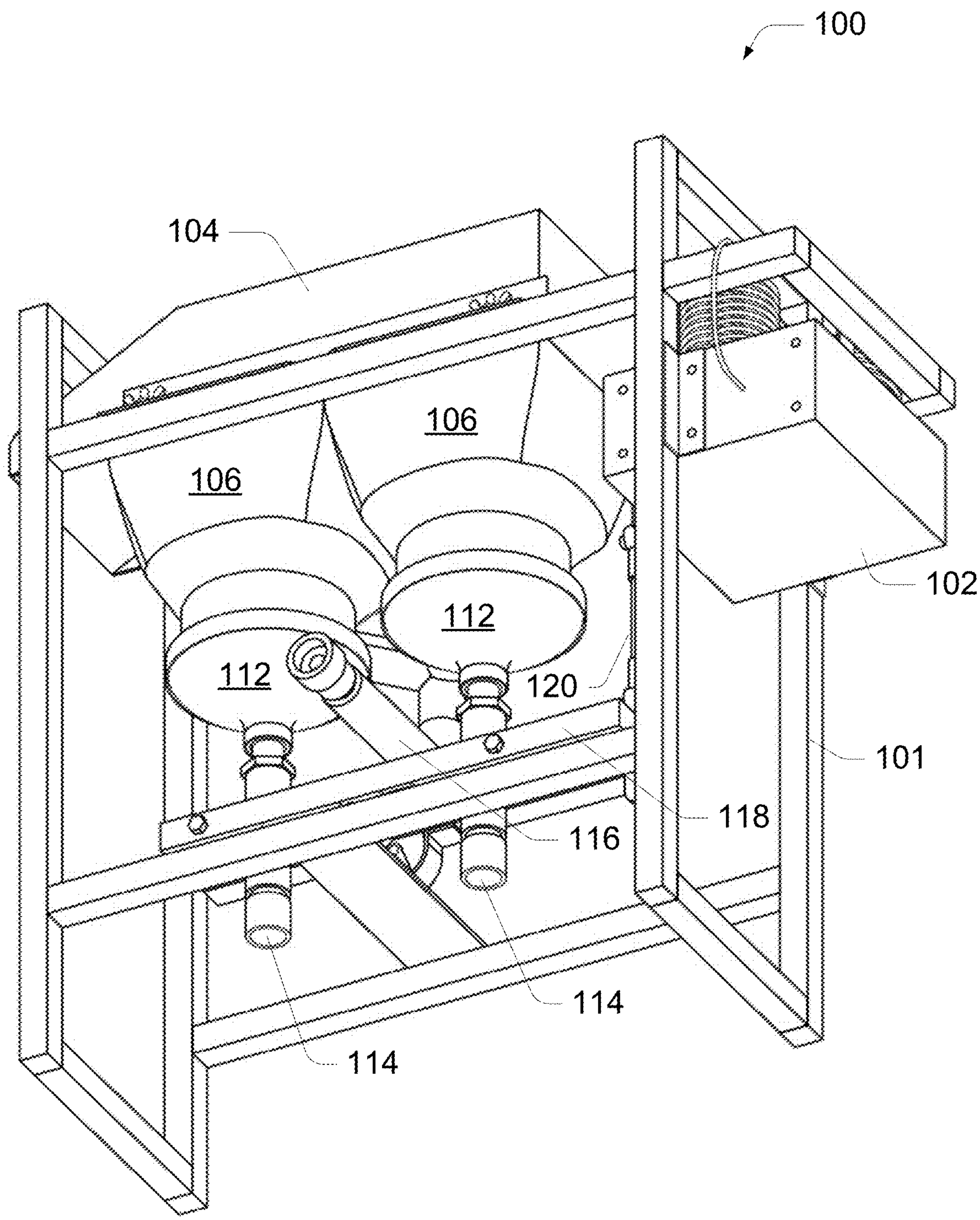
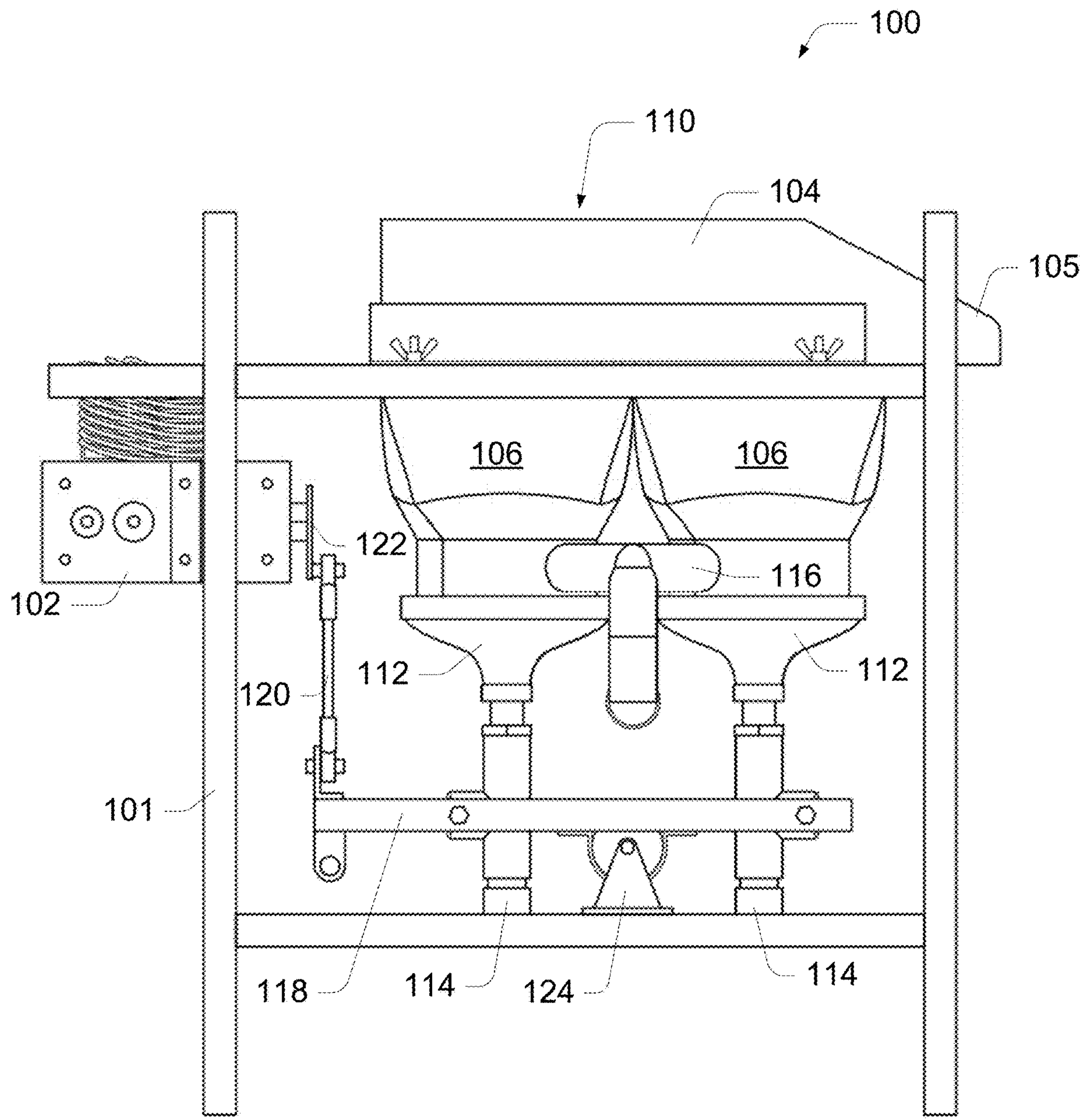


FIG. 2


100
110
104
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106
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122
116
102
112
112
120
101
118
114
124
114

FIG. 3

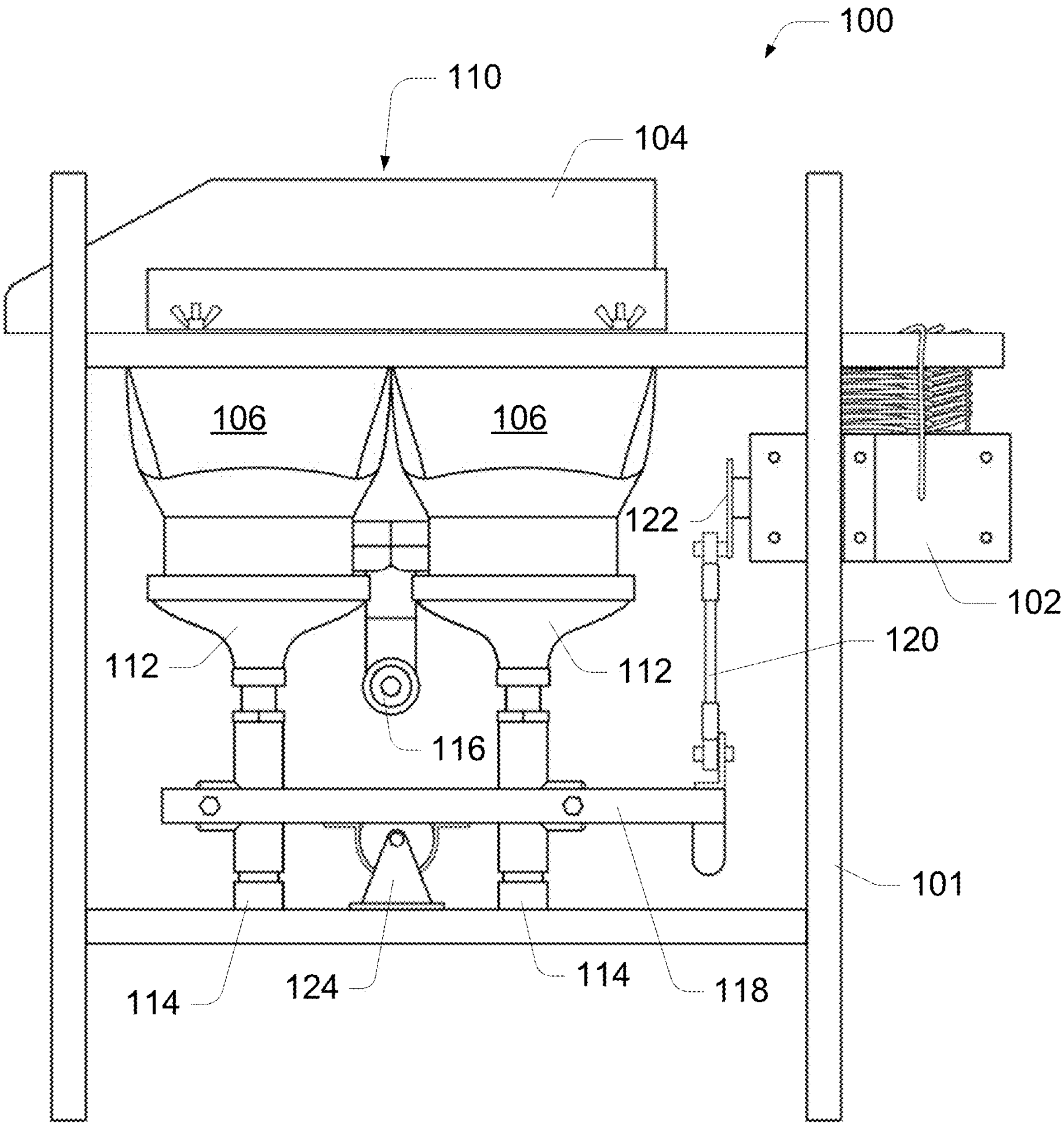


FIG. 4

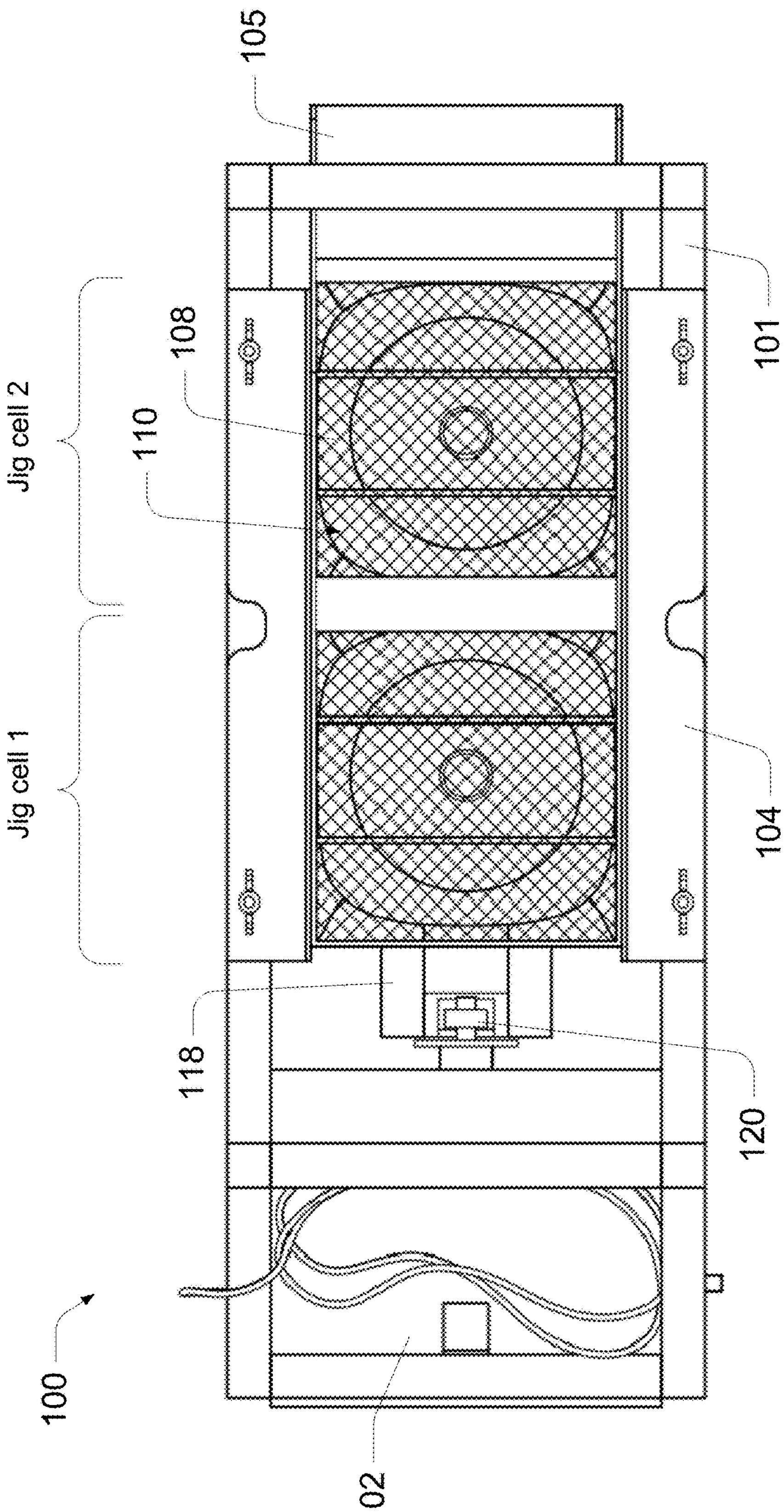


FIG. 5

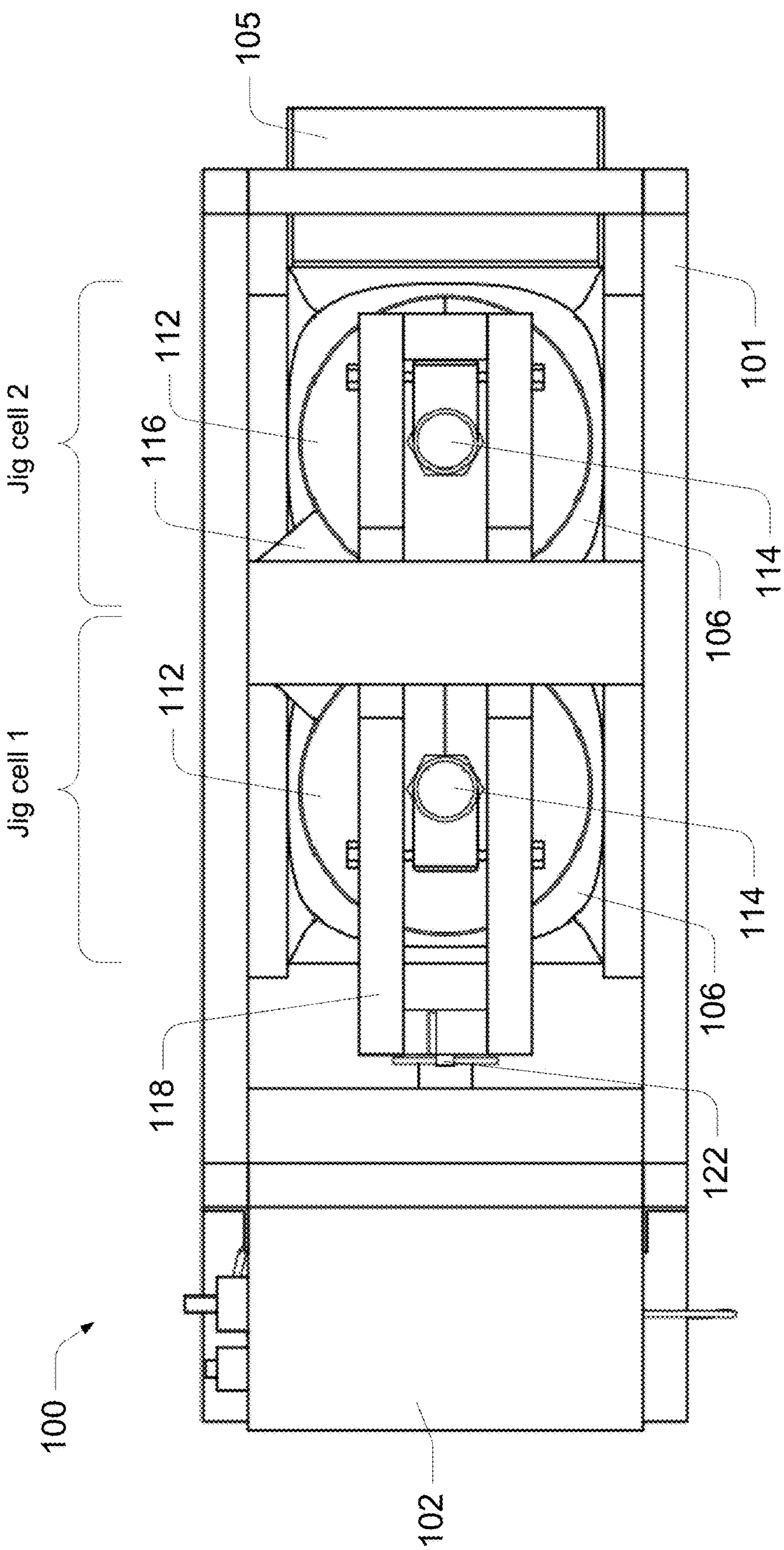

105
101
Jig cell 2
112
116
114
106
Jig cell 1
112
114
106
118
122
100
102

FIG. 6

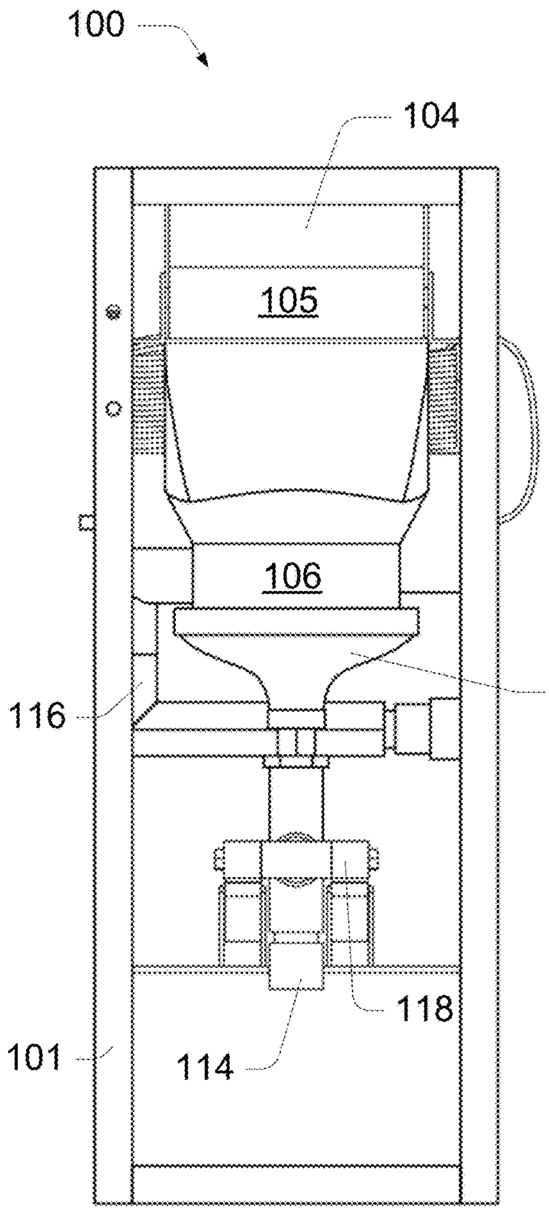

100
104
105
106
116
112
118
101
114

FIG. 7A

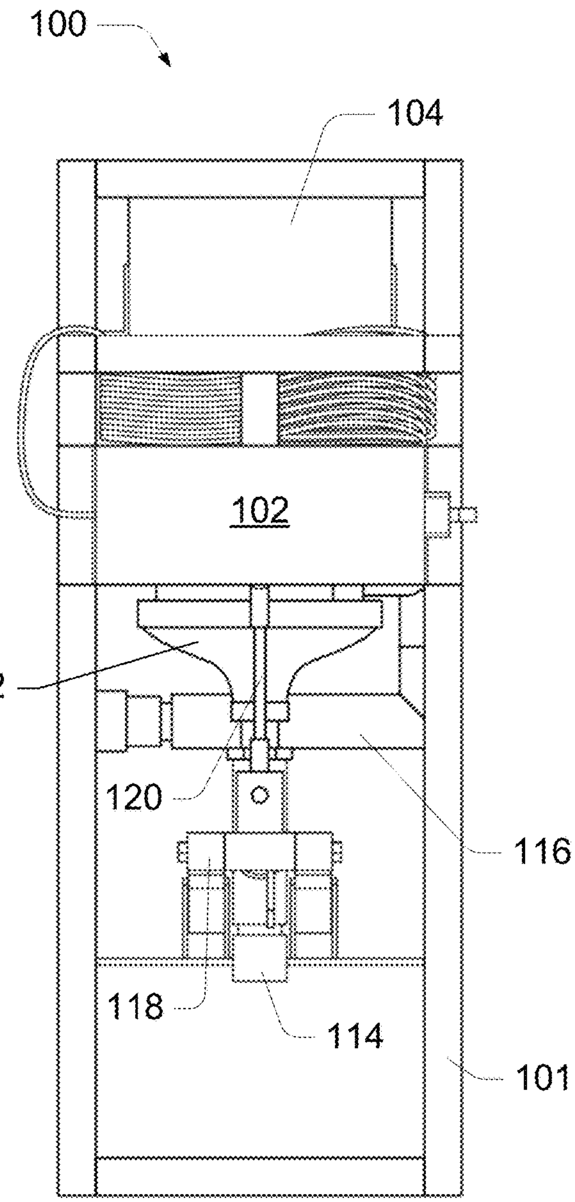

100
104
102
112
120
116
118
114
101

FIG. 7B

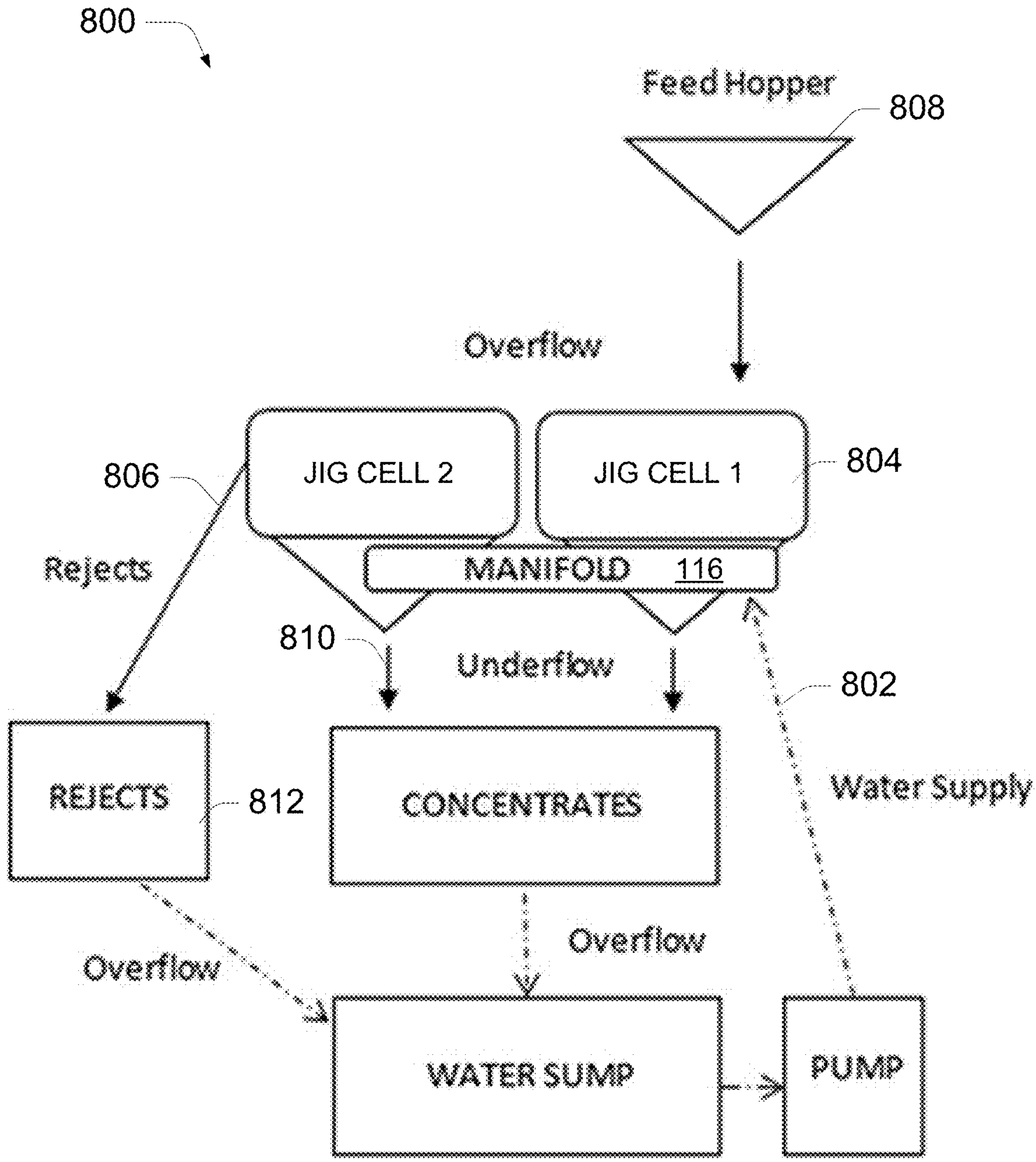

800
Feed Hopper
808
Overflow
JIG CELL 2
JIG CELL 1
804
806
Rejects
MANIFOLD 116
810
Underflow
802
REJECTS
812
CONCENTRATES
Water Supply
Overflow
Overflow
WATER SUMP
PUMP

FIG. 8

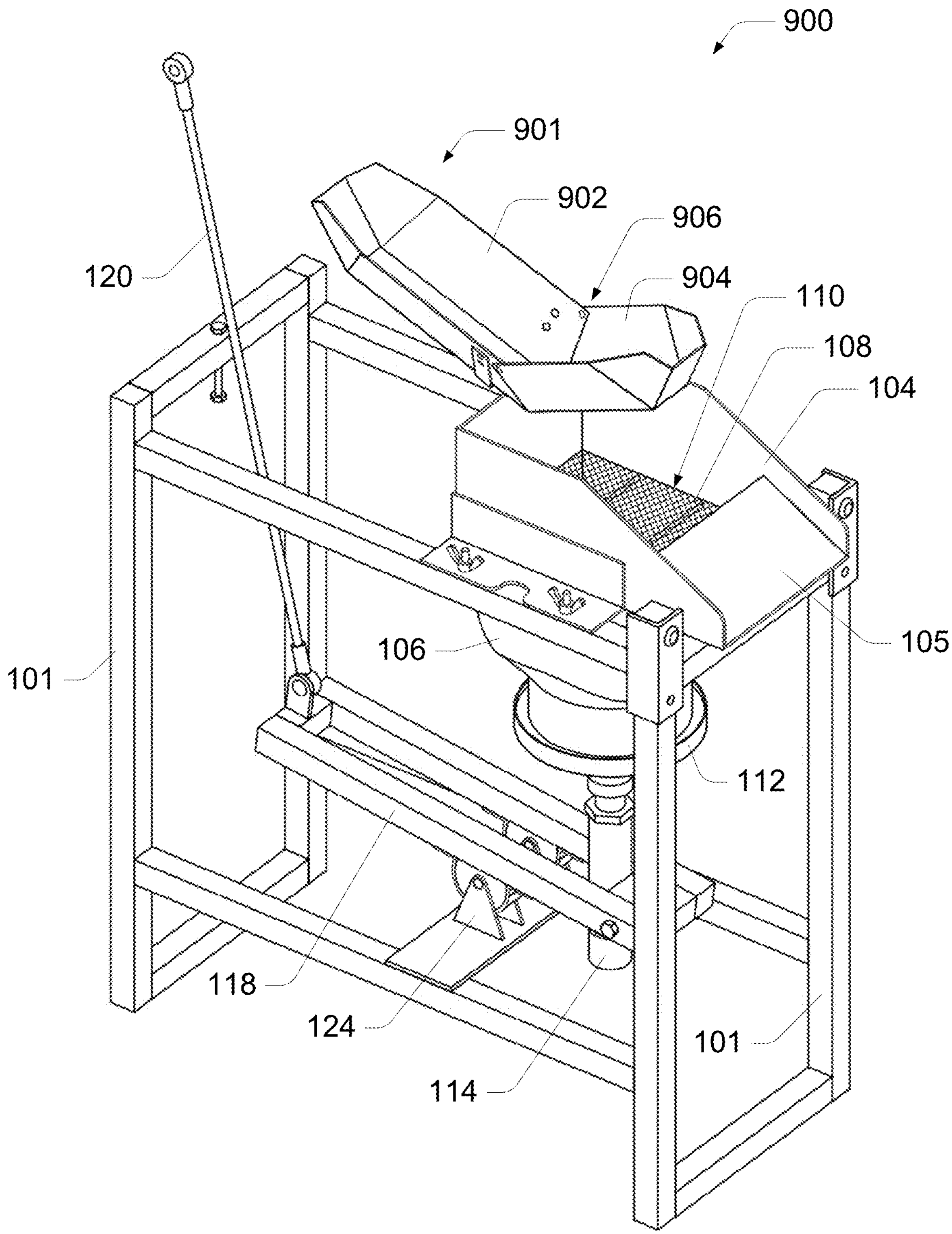

900
901
902
906
904
110
108
104
120
105
106
101
112
118
124
101
114

FIG. 9

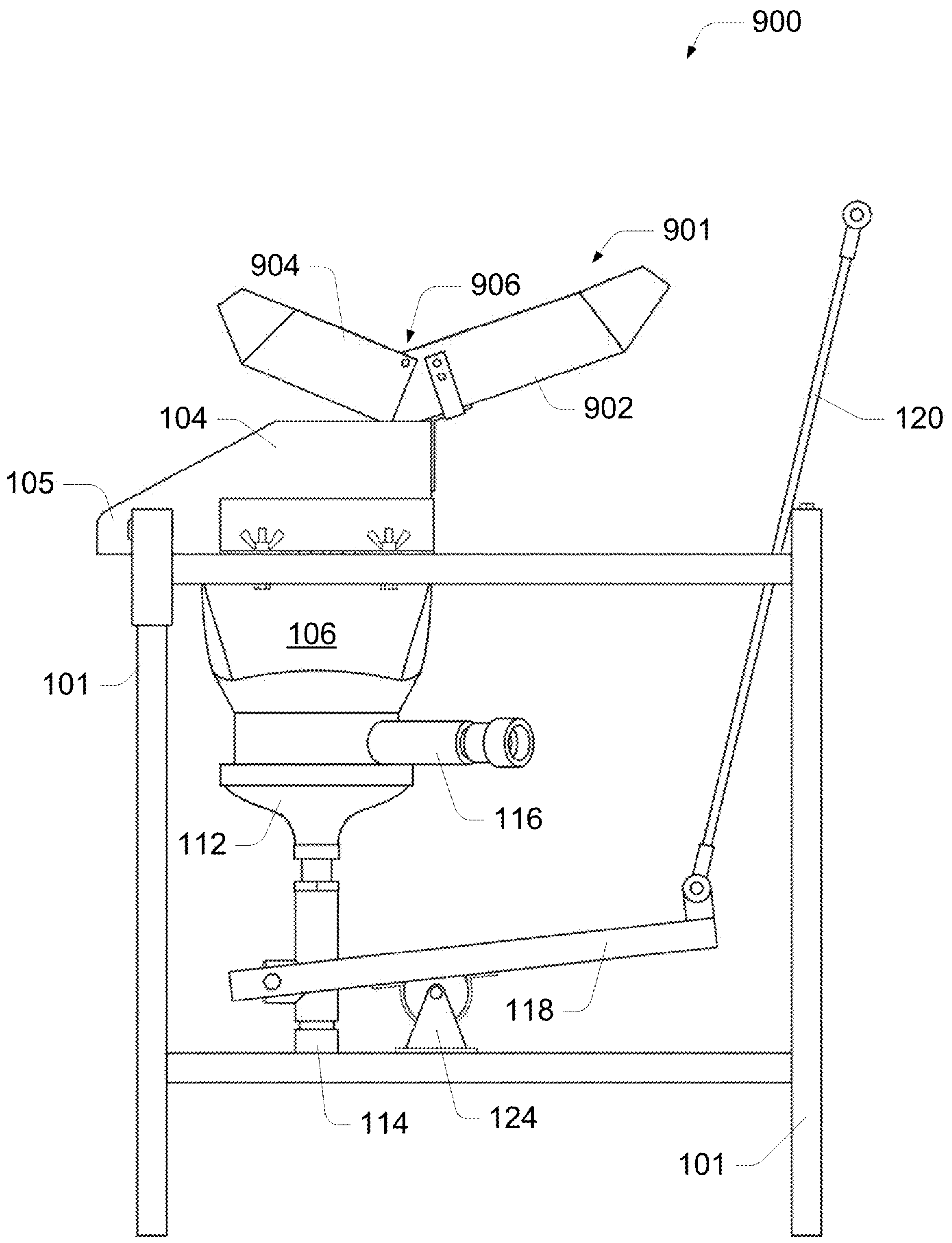


FIG. 10

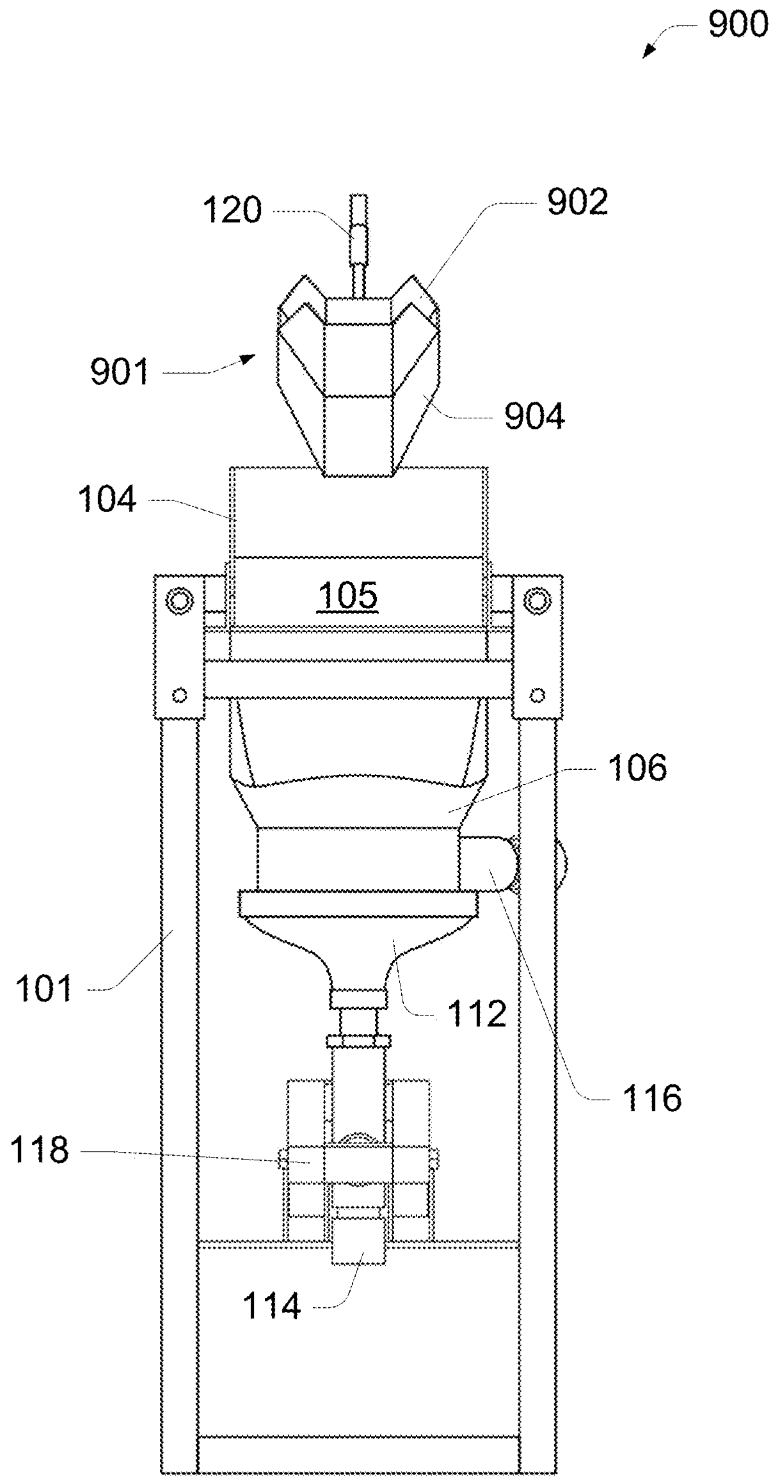


FIG. 11

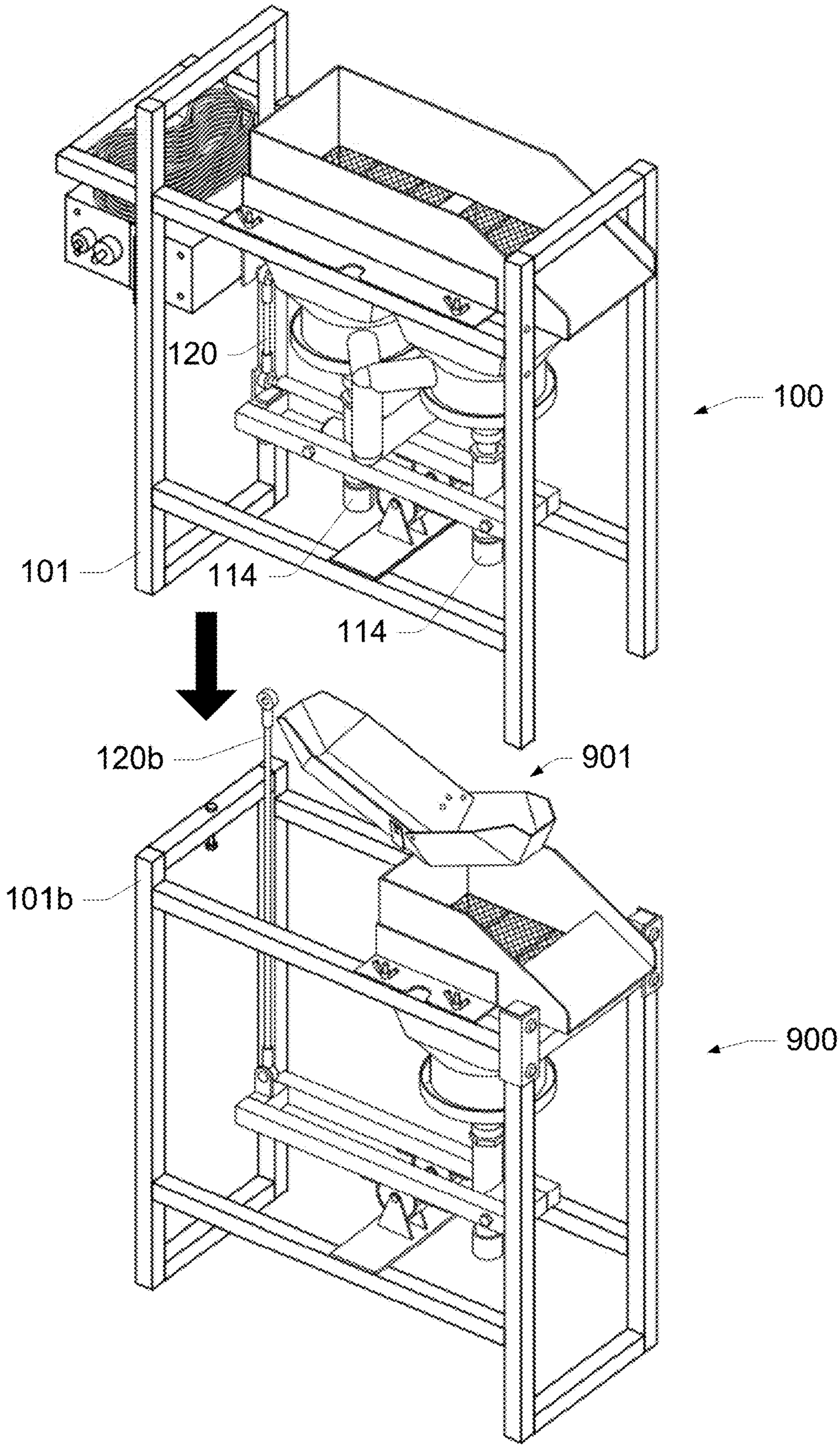


FIG. 12

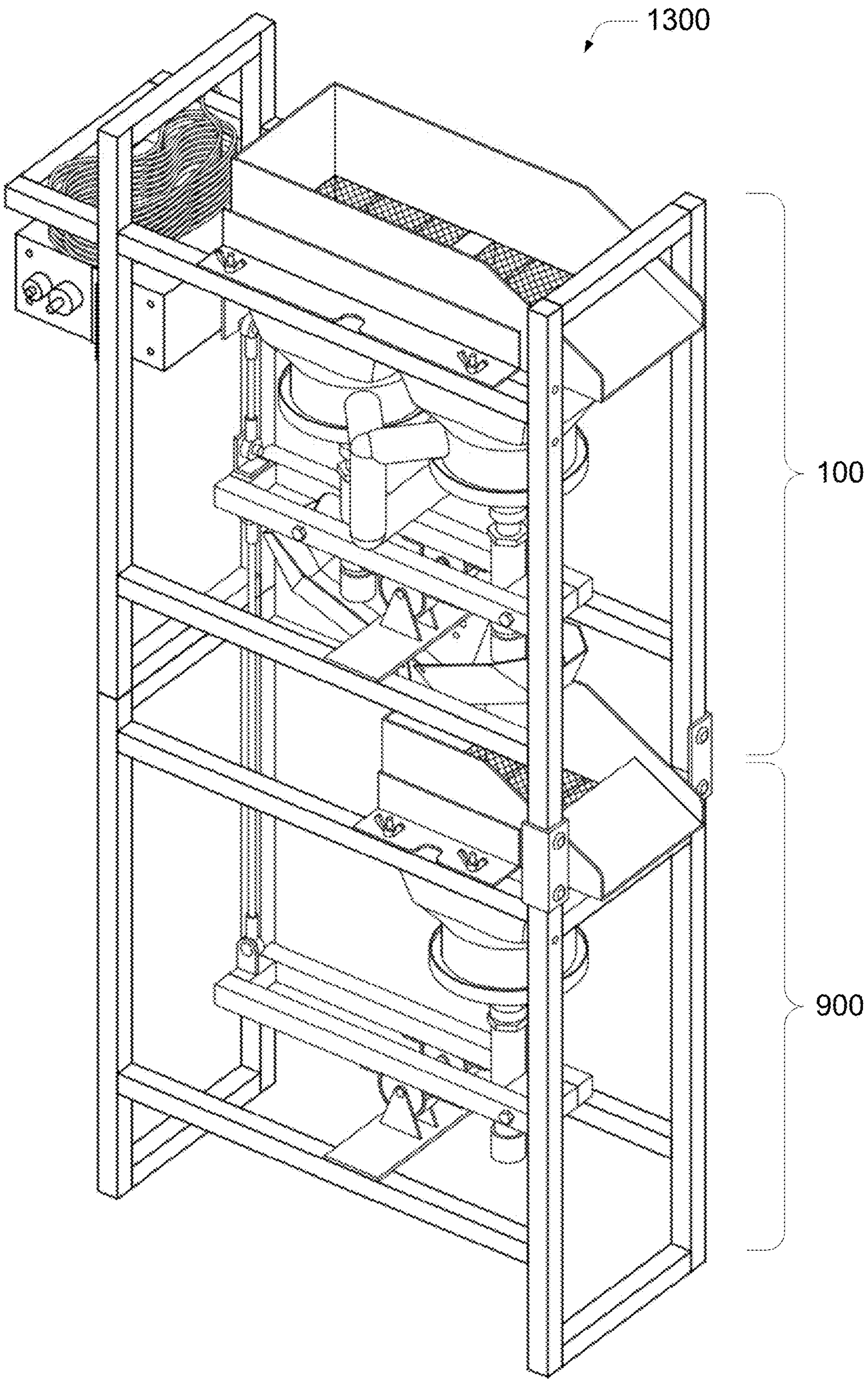
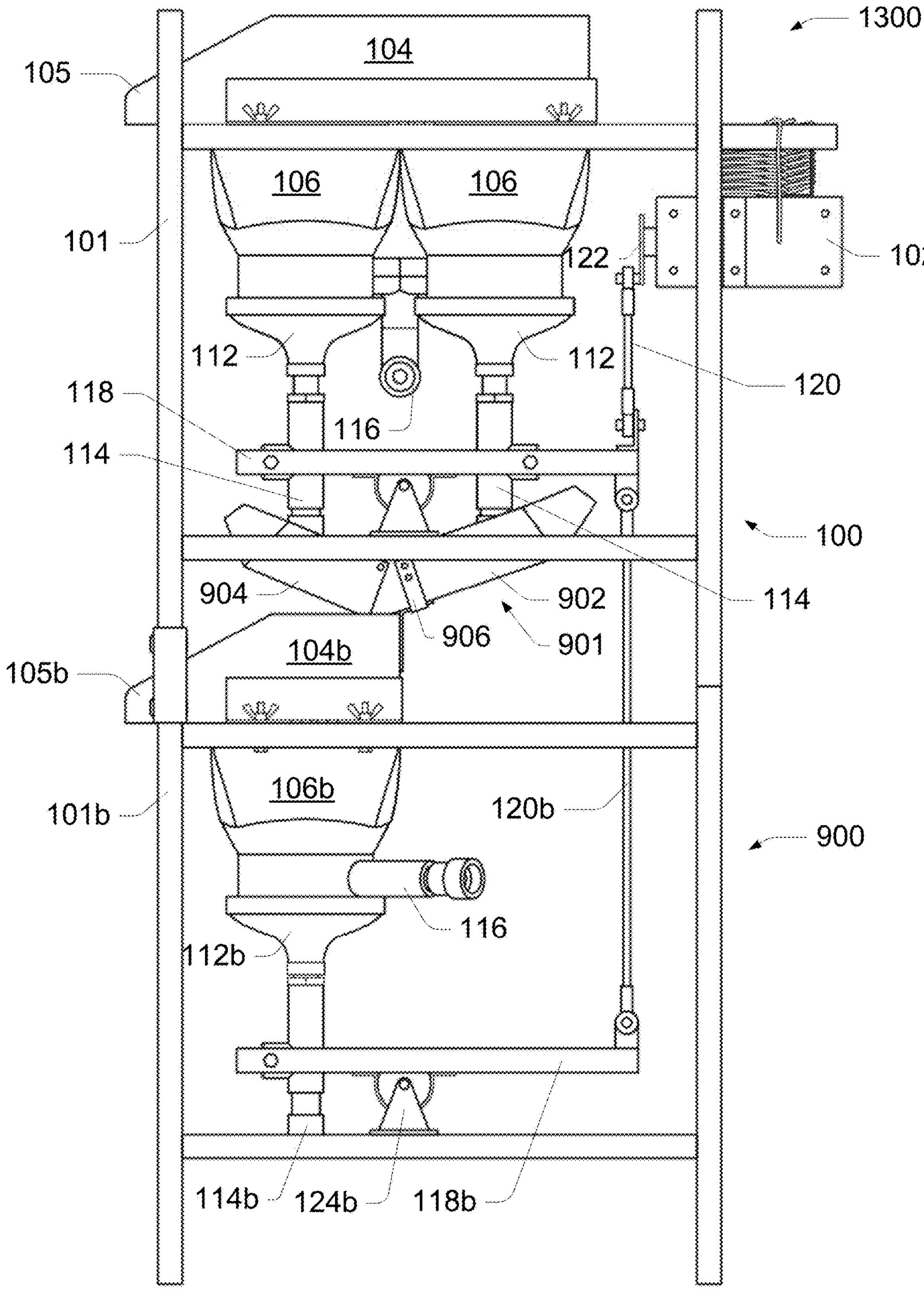


FIG. 13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101
122
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112
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118
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100
904
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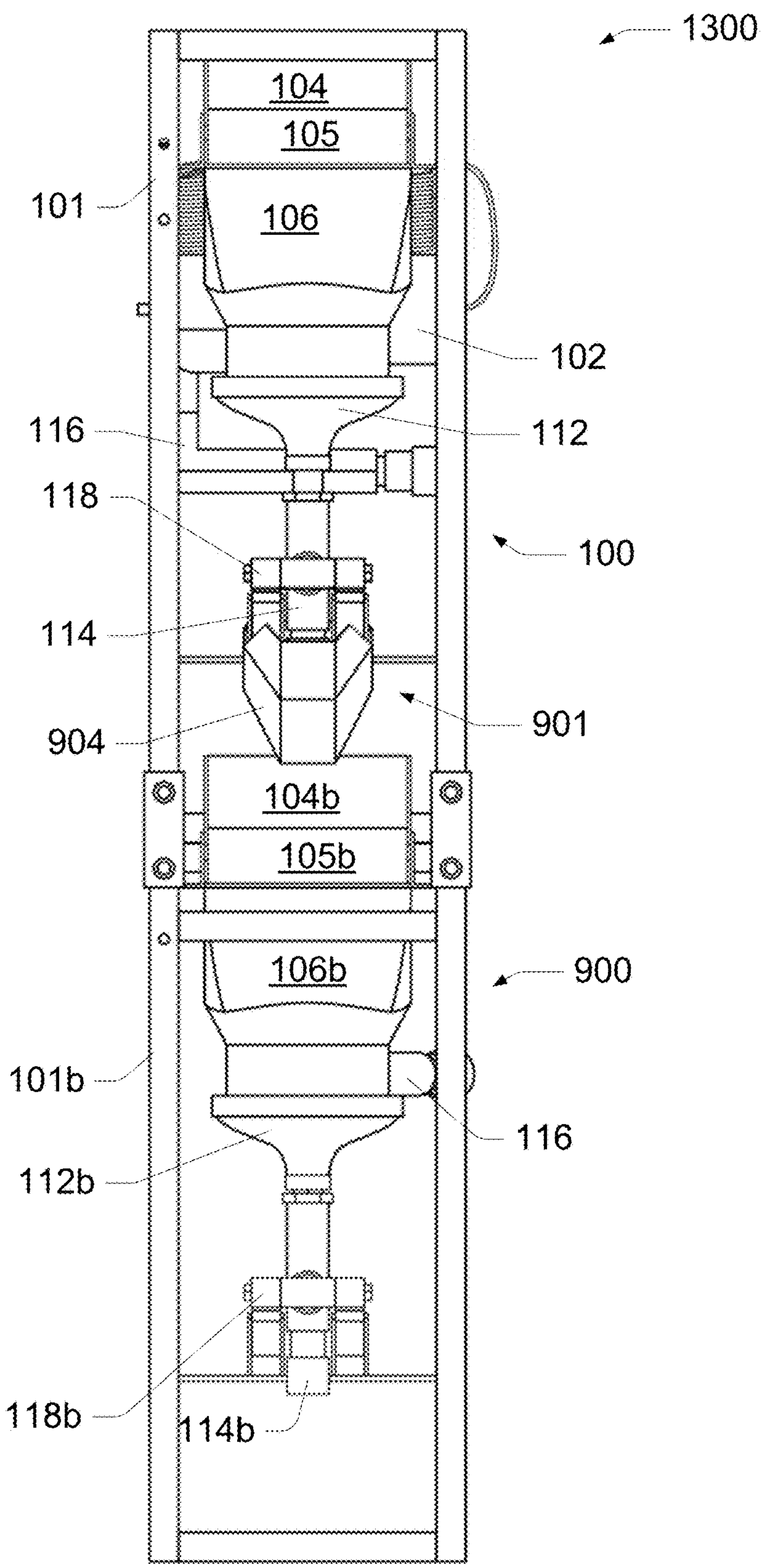
114
906
901
104b
105b
106b
101b
120b
900
116
112b
114b
124b
118b

FIG. 14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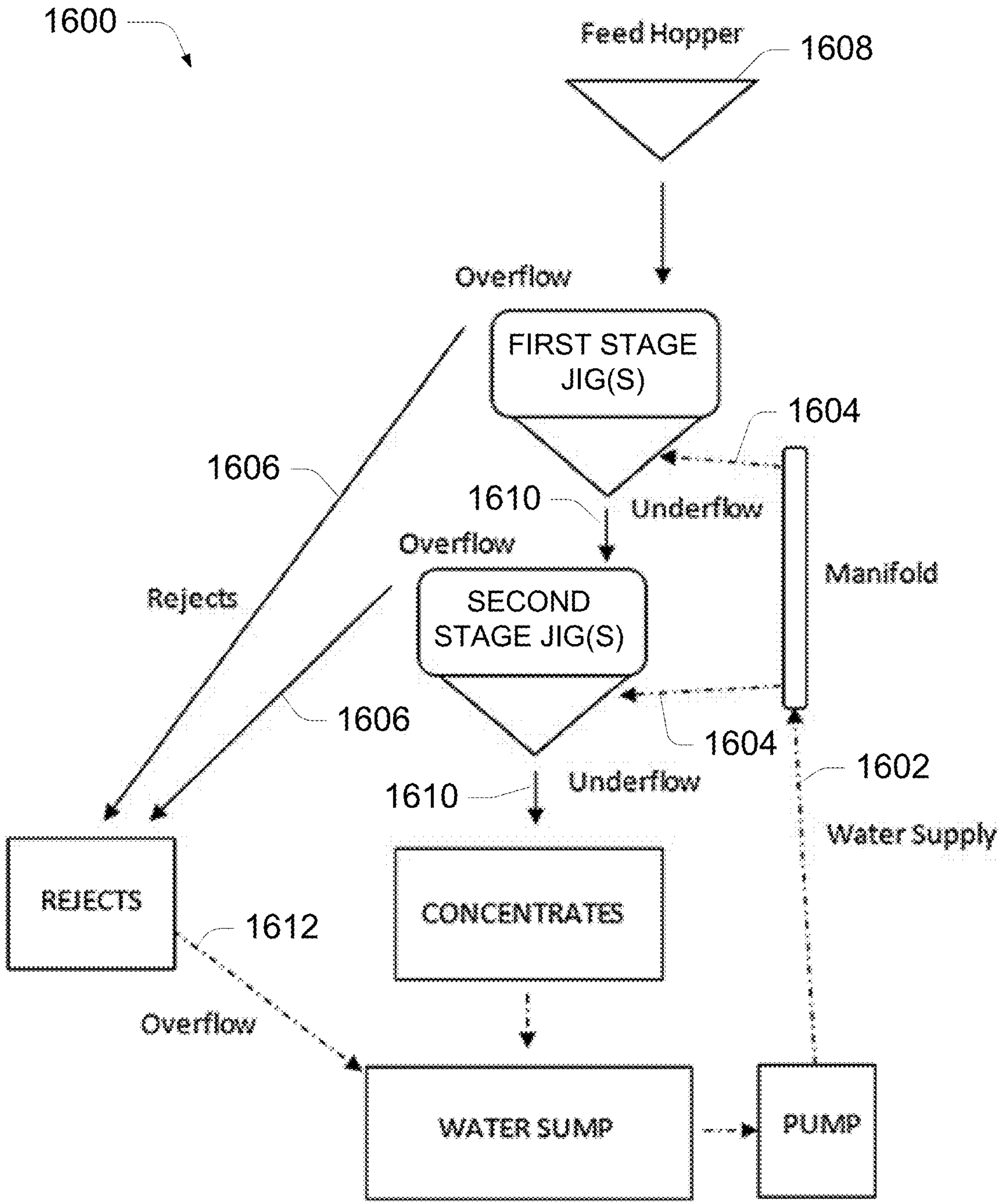
101
106
102
116
112
118
100
114
901
904
104b
105b
106b
900
101b
116
112b
118b
114b

FIG. 15



1600
Feed Hopper
1608
Overflow
FIRST STAGE JIG(S)
1604
1606
1610
Underflow
Overflow
Manifold
Rejects
SECOND STAGE JIG(S)
1606
1604
1602
1610
Underflow
Water Supply
REJECTS
CONCENTRATES
1612
Overflow
WATER SUMP
PUMP

FIG. 16

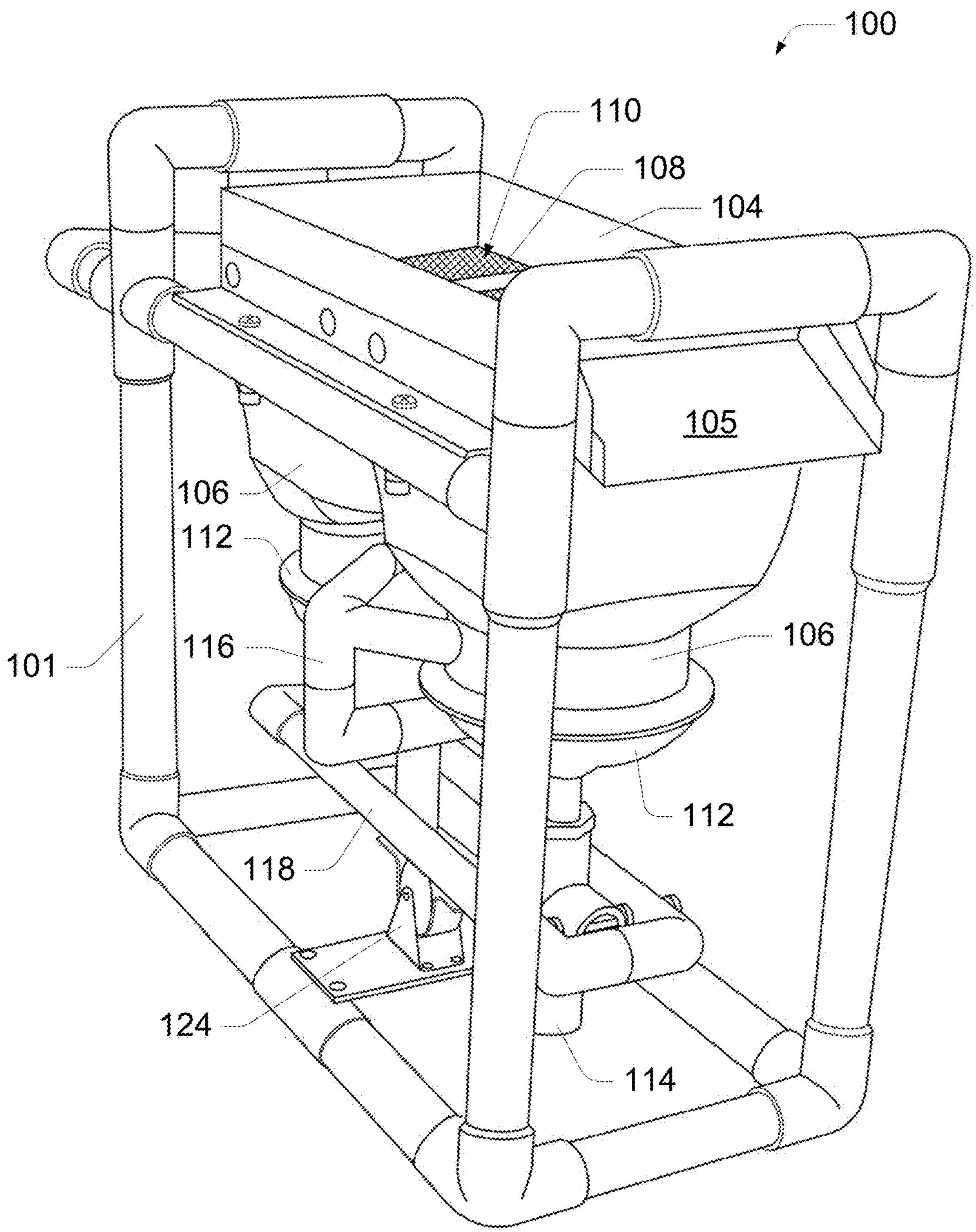
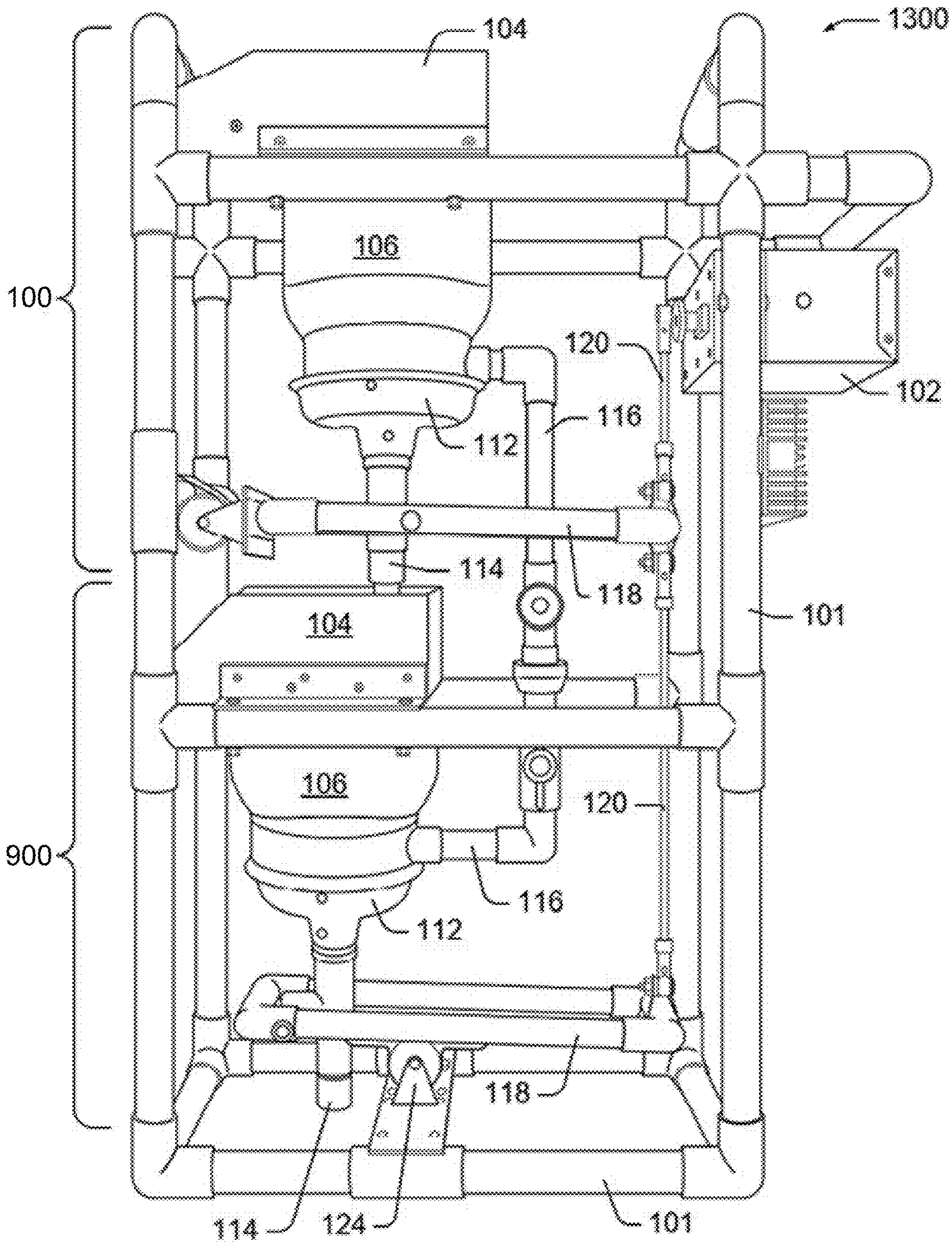


FIG. 17


1300
104
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116
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114
118
101
104
106
900
120
116
112
118
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124
101

FIG. 18

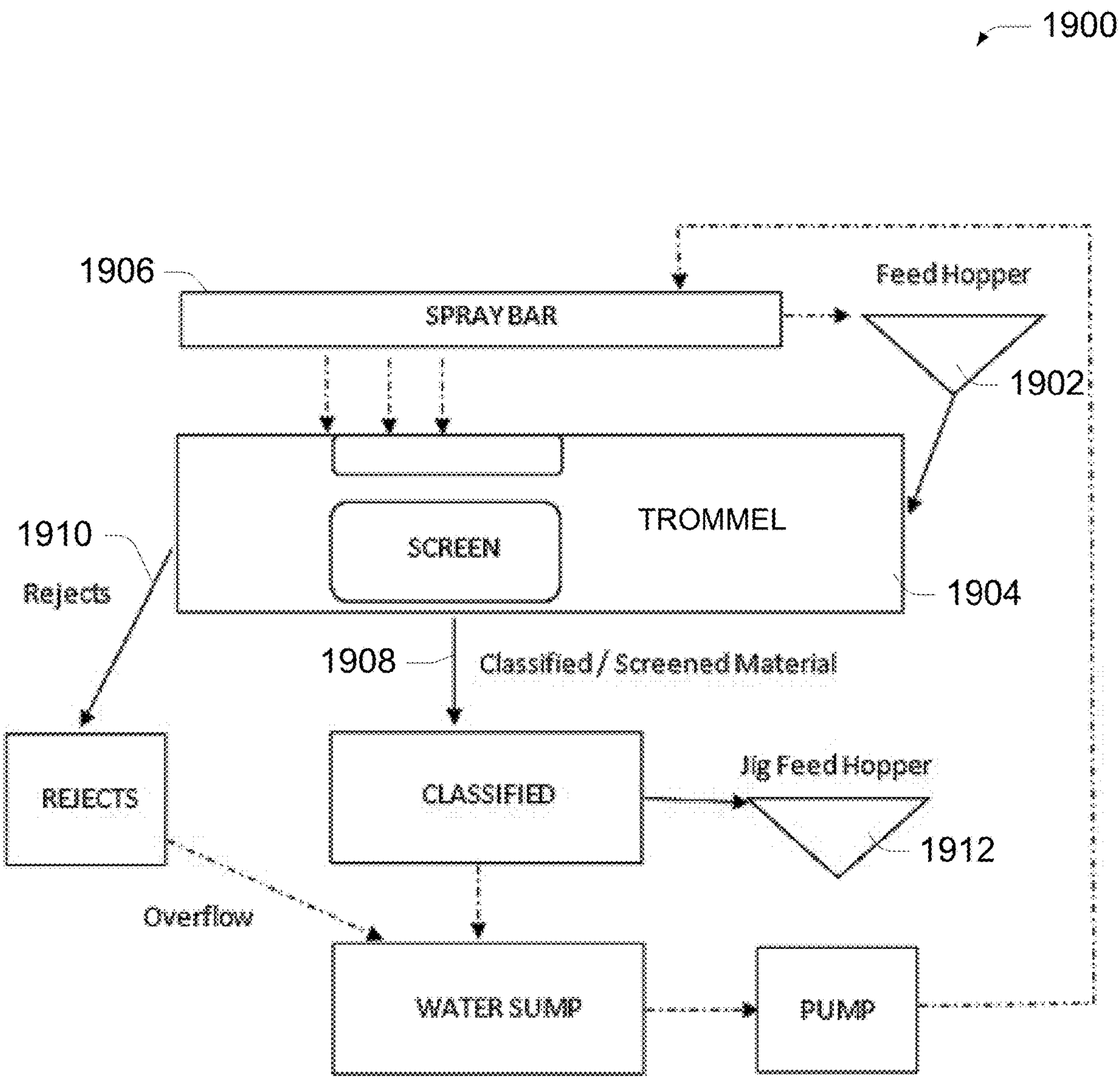
1900
1906
SPRAY BAR
Feed Hopper
1902
TROMMEL
SCREEN
1910
Rejects
1904
1908
Classified / Screened Material
REJECTS
CLASSIFIED
Jig Feed Hopper
1912
Overflow
WATER SUMP
PUMP

FIG. 19

MULTI-CONFIGURATION MINI JIG

PRIORITY CLAIM AND CROSS-REFERENCE TO RELATED APPLICATION

This application claims the benefit under 35 U.S.C. § 119(e)(1) of U.S. Provisional Application No. 63/509,011, filed Jun. 19, 2023, which is hereby incorporated by reference in its entirety.

BACKGROUND

While many who mine gold are looking for larger nuggets or flakes, fine gold can make up a larger percentage of available gold in placer deposits. Placer deposits are those that have been released from a larger gold deposit due to environmental effects (such as gold in a river or stream bed from erosion, etc.). Fine gold is generally considered to be the gold particles that are more difficult to pick up with hands or many tools (e.g., about one half of one millimeter or less in diameter).

However, fine gold can be extremely difficult to trap effectively. Sluice boxes and gold pans, for example, can be very inefficient at mining fine gold. Sluice boxes and similar mining methods separate material by size or by weight, but not both, and not efficiently. Much of the fine gold is combined with waste and is not captured.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description is set forth with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items.

For this discussion, the devices and systems illustrated in the figures are shown as having a multiplicity of components. Various implementations of devices and/or systems, as described herein, may include fewer components and remain within the scope of the disclosure. Alternately, other implementations of devices and/or systems may include additional components, or various combinations of the described components, and remain within the scope of the disclosure. Shapes and/or dimensions shown in the illustrations of the figures are for example, and other shapes and or dimensions may be used and remain within the scope of the disclosure, unless specified otherwise.

FIG. **1** is a top perspective view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **2** is a bottom perspective view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **3** is a left side view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **4** is a right side view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **5** is a top view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **6** is a bottom view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **7**A shows a front view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **7**B shows a back view of an example single-stage duplex mini jig, according to an embodiment.

FIG. **8** shows a flow diagram of an example operation of a single stage mini jig, according to an embodiment.

FIG. **9** is a perspective view of an example second-stage simplex mini jig, according to an embodiment.

FIG. **10** is a side view of an example second-stage simplex mini jig, according to an embodiment.

FIG. **11** is a front view of an example second-stage simplex mini jig, according to an embodiment.

FIG. **12** is a perspective view of an example single-stage duplex mini jig being mated to a second-stage simplex mini jig, according to an embodiment.

FIG. **13** is a perspective view of an example two-stage mini jig, according to an embodiment.

FIG. **14** is a side view of an example two-stage mini jig, according to an embodiment.

FIG. **15** is a front view of an example two-stage mini jig, according to another embodiment.

FIG. **16** shows a flow diagram of an example operation of a multistage mini jig, according to an embodiment.

FIG. **17** is a perspective view of an example single-stage mini jig, according to another embodiment.

FIG. **18** is a side view of an example two-stage mini jig, according to another embodiment.

FIG. **19** shows a flow diagram of an example operation of a trommel, according to an embodiment.

DETAILED DESCRIPTION

Overview

Referring to FIGS. **1-18**, the document herein discloses example embodiments of a modular multi-configuration mini mining jig system (hereinafter "mini jig **100**"). The mini jig **100** comprises a portable mining machine or system, which can be used to mine finely subdivided minerals, such as fine gold, from collected soil.

The modular characteristic of the mini jig **100** allows various configurations of portable mining jigs to be assembled or arranged using a set of common components and a few house-hold tools (one 7/16 inch open end wrench and one 3/16 inch hex wrench, for example).

For instance, the mini jig **100** can comprise a kit that includes the common components, and which can include a power supply (such as a battery), a water pump, and may also include the tools used for assembly. The mini jig **100** is designed to be small and lightweight, to allow a user to easily carry and deploy the mini jig **100** into remote environments that may be inaccessible to vehicles. For instance, in some cases, the mini jig **100** (including associated components of the kit) can be carried in a backpack or similar carrier to be carried by the user to a remote location.

The modular components of a mini jig **100** can be assembled or arranged into various arrangements: as a single-stage jig (see FIG. **1**, for example), with one or two (or more) primary jig cells, or as a multi-stage jig (see FIG. **12**, for example) with one or two (or more) jig cells per stage. Accordingly, a mini jig **100** arrangement can include one, two, or more stages, with one, two, or more jig cells per stage. In an embodiment, a mini jig **100** kit includes the components to assemble more than one arrangement of a mini jig **100**, and may contain the components to assemble many arrangements.

Including FIGS. **1-18**, the disclosure herein includes drawings, diagrams, flow charts, and descriptions of various embodiments of a mini jig **100**. Dimensions and materials of components are non-limiting examples, unless otherwise specified. Other dimensions, materials, proportions, and specifications are also contemplated and are within the scope of the disclosure.

Mineral jigs such as the mini jig **100** can be efficient at trapping fine gold because unlike other types of gold mining equipment, mineral jigs separate material by size and specific gravity, and with much less water than other mining devices. Many other mining methods separate material either by size or by weight, but not both, and not efficiently. In some cases, mineral jigs can have less capacity (throughput) than sluice boxes, so most mineral jigs are large (to improve throughput), expensive, heavy, and loud.

Mineral jigs are manufactured as primary (large volume and rough screening), secondary (smaller capacity and fine screening), or tertiary (smallest volume and ultra-fine screening) gold recovery machines. Operating a tiered or multi-stage mineral jig system generally requires multiple high voltage motors and slurry pumps, at least one large water pump, and a high capacity generator. Even single mineral jigs commonly weigh several hundred pounds. A multi-stage system can weigh several tons.

The instant disclosure describes a solution in a truly portable, multi-stage mineral jig system. The modular mini jig **100** can be configured to perform as a single-stage, duplex, primary jig set, as a two-stage, duplex, secondary and tertiary jig set, or as a jig set with additional jig cells and/or stages. Due to the modular nature of the mini jig **100** components, any number of jig cells and stages are possible. Adding jig cells and stages increases the throughput and capacity of the system, which increases efficiency.

A modular mini jig **100** kit can include all the parts to reconfigure a mini jig **100** from a single-stage duplex arrangement (see FIG. **1**, for example) to a two-stage arrangement (see FIG. **13**, for example), or other arrangements. Kits can also include additional modular components that can be used to arrange a mini jig **100** in multiple configurations, if desired. Reconfiguration of a mini jig **100** by the user is simple and easy in the field using the modular components and just a few tools.

In an example, the frame of a mini jig **100** can be comprised of aluminum (or other metal, composite, carbon fiber, fiberglass, etc.) straight tubes, tubular joints (including tubular "T" sections), and tubular elbows (or like components) which can be modularly arranged and re-arranged to form frames in various shapes and sizes as desired to fit and hold mini jig **100** cells and associated components in single-stage and multi-stage mini jig **100** arrangements. The mini jig **100** cells and components can be universal, to be used with each of the several mini jig **100** arrangements and configurations. The single motor included with a mini jig **100** kit can be used with single-stage and multi-stage mini jig **100** arrangements to drive one or more rocker arms, using included drive link components.

In another example, the frame of a mini jig **100** can be comprised of schedule **40** (or other dimension) PVC straight tubes, tubular joints (including tubular "T" sections), and tubular elbows (or like components) which can be modularly arranged and re-arranged to form frames in various shapes and sizes as desired to fit and hold mini jig cells and associated components in single-stage and multi-stage mini jig **100** arrangements. The mini jig cells and components can be universal, to be used with each of the several mini jig **100** arrangements and configurations.

When deployed, a mini jig **100** uses one approximately 750-1500 gallons per hour (gph) from a water source (e.g., pump) and one power source (12 volt battery, for example). In one example, a single lithium battery weighing approximately 5 lbs can power a mini jig **100** machine an entire day.

Example Embodiments of a Multi-Configuration Mini Jig

In various embodiments, a mini jig **100** can have one or more of the following characteristics:

1. A single mini jig **100** mining machine is capable of single-stage or multi-stage mineral (e.g., gold) recovery configurations.
2. A mini jig **100** (or mini jig kit) can include a duplex drive system, which includes at least two jig cells (e.g., 5.5 inch each) operated by a single drive motor with opposing up/down action by means of linked rocker arms.
3. A mini jig **100** (or mini jig kit) is light weight (approximately 15-20 lbs.) for true portability. For instance, in some embodiments, the primary frame construction is aluminum tubing with aluminum (or other lightweight material) components. In other embodiments, the primary frame construction is schedule **40** polyvinyl chloride (PVC) tubing with aluminum (or other lightweight material) components. Other lightweight frame materials (e.g., carbon fiber, fiberglass, composite, etc.) are also contemplated.
4. A mini jig **100** is compact (some embodiments can have dimensions of approximately 32"×22"×9") and can be backpacked, hauled on an ATV, or transported via personal watercraft or aircraft.
5. A mini jig **100** (or mini jig kit) is modular, where the major components are exchangeable and can be used in multiple configurations.
6. A mini jig **100** concentrates gold bearing material more efficiently than a sluice box.
7. A mini jig **100** in a multi-stage configuration provides more efficient concentration than single stage mineral jig.

In various embodiments, a mini jig **100** can have one or more of the following construction characteristics and can be made of one or more of the following example materials (or similar other materials):

1. The jig hutch **106** can be constructed of thermoformed poly vinyl chloride (PVC).
2. The frame **101**, rocker arms **118**, and piping **116** can be constructed of aluminum, fiberglass, carbon fiber, poly vinyl chloride, and like lightweight materials.
3. The motor **102** mount, mounting plates, chutes **105**, jig trays **104**, and shrouds can be made of aluminum or other rigid lightweight materials.
4. The jig diaphragms **112** can be made from rubber or a material with like properties.
5. The drive cam can be made of mild steel or another durable material.
6. The drive links **120** and other metal components can be made of steel alloy or another durable material.

Example Single Stage Mini Jig

Referring to FIGS. **1**-**7**B, a single stage mini jig **100** is shown, according to an embodiment. The single stage mini jig **100** is shown as a duplex jig, having two jig cells (jig cell **1** and jig cell **2**) in a single stage. The jig cells are side-by-side and operate concurrently. For instance, both jig cells (jig cell **1** and jig cell **2**) can be driven by a single motor **102**. Other single stage mini jigs **100** may have a single jig cell or more than two jig cells in the single stage. Adding jig cells improves efficiency, including throughput.

A modular mini jig **100** cell can include the following components: A jig tray **104** with a discharge chute **105**, a jig hutch **106**, one or more jig screens **108**, a quantity of jig bed media **110**, a diaphragm **112**, and an underflow or discharge tube **114**. A jig cell may have additional components or equivalent components. Any quantity of jig cells can be used with a mini jig **100**, and can be arranged in a side-by-side arrangement per stage (see FIG. **1**, for example) and in multi-stage arrangements (see FIG. **16**, for example) in a frame **101**. Depending on the arrangement, during operation a manifold **116** continually feeds water into the hutch **106** and over the jig bed media **110**. Typically a single rocker arm **118** per stage is coupled to the motor **102** via drive links **120** and moves the diaphragm **112** of each jig cell in an up and down motion. Multiple rocker arms **118** per stage are also possible, or other jigging mechanisms that move the diaphragm **112** of each jig cell in the up and down motion. These can be coupled to the motor **102** using drive links **120**. Springs may also be used to assist the up and down motion of the diaphragms **112**.

During operation, supply water fills each jig hutch **106** via a manifold **116** and overflows the jig tray **104**, exiting the front of the jig tray **104** at the discharge chute **105**. Waste (or tailings) that is less dense than the minerals of interest can exit the discharge chute **105** with the overflow of water. A portion of the water also exits at each underflow nipple **114** at a low portion of each diaphragm **112** directly below each hutch **106**.

Each jig tray **104** contains a screen **108** of mesh (e.g., stainless steel or the like). For instance, the screen **108** can comprise a **30**, **60**, or **100** grid mesh, depending on the screen size desired. The size of the screen **108** determines the size of the particles (e.g., minerals) that will pass through it. On the screen **108** can be disposed 3 or 4 layers (for example) of jig media, such as steel balls (e.g., ¼ inch jig shot or the like) that acts as a bedding material **110**. Feed material, or soil that contains the minerals, is placed on the bedding **110**.

The rocker arm **118** is coupled at one end to the motor **102**, via one or more drive links **120**. Each end (one or both, depending on the number of jig cells) of the rocker arm **118** is connected to a jig diaphragm **112** and the rocker arm **118** is pivotally coupled to the frame **101**. The ends of the rocker arm **118** are driven up and down as the rocker arm **118** moves in a pivoting action at approximately 300 strokes per minute (or other suitable rate) as driven by the motor **102**. The throw of the rocker arm **118** ends can be about 1.5 inches, for example, "jigging" the lower portion of the diaphragms **112** by that distance, which pushes water up and into the jig cells and the jig tray **104**, and thereby moves the hutch **106** water and bedding **110** up and down at the same frequency (e.g., about 300 strokes per minute).

The feed material (containing minerals mixed with waste) passes over the bedding **110**, and the light particles are washed and bounced out the front chute **105** of the jig tray **104** with the overflow water. Heavy or dense particles (e.g., minerals) fall into the bedding **110**, slipping between the jig shot with each up stroke of the rocker arm **118** as the bedding **110** lifts and separates, and are trapped as each down stroke sucks the bedding **110** back down and together. The heavy particles begin to slip through the screen **108** or enhance the effectiveness of the bedding **110** (if they stay trapped on the jig bed screens **108**).

As more feed material is introduced to the jig tray **104**, the densest and heaviest particles begin to displace those with less specific gravity, thus the reason for steel jig shot or like jig bedding media **110**. The heavy particles that pass through the screen **108** (i.e., concentrates) are discharged from the hutch **106** via the under flow nipple **114**. These heavy particles can be collected in a concentrates container.

Flowchart Showing an Example of Operation

The operation of an example single stage mini jig **100** as shown in the embodiments of FIGS. **1**-**7**B and **17** can be described with the flow chart illustrated at FIG. **8**. Note that the example single stage mini jig **100** shown in the embodiments of FIGS. **1**-**7**B is a duplex jig, meaning that there are two side-by-side jig cells (jig cell **1** and jig cell **2**) at a single stage. A single stage mini jig **100** with one jig cell or more than two jig cells operates in a similar manner, as described herein.

At block **802**, water is pumped into the intake manifold **116**, which is coupled to each jig cell at the respective hutch **106**. At block **804**, the water fills and overflows each jig cell at each hutch **106**, flowing across the top of the jig tray **104**, from the first jig cell (jig cell **1**, at the rear) to the second jig cell (jig cell **2**, at the front). At block **806** the overflowing water flows off the discharge chute **105** (see FIG. **5**, for example). Water also discharges from the bottom of each jig cell through a flow-limited discharge tube **114** (underflow).

As shown at FIGS. **3** and **4**, the rocker arm **118** is coupled to the motor **102** via a mechanical cam **122**, which causes the rocker arm **118** to pivot at pivot point **124** as the motor **102** turns. As each end of the rocker arm **118** rises and falls with the pivot of the rocker arm **118**, the diaphragm **112** coupled to the rocker arm **112** end(s) moves in a jigging action. The up and down jigging action of the diaphragm **112** under each jig cell causes the jig bed media **110** (a bed of jig media, such as steel balls, etc. resting on the classifying screen **108** in each jig cell) in each tray **104** to rise and fall. Each up stroke increases the upward flow of water in the respective hutch **106**, lifting and separating the jig bed media **110**. Each down stroke of the diaphragm **112** pulls the jig bed media **110** down and together.

At block **808**, feed material (e.g., soil, etc.) bearing gold or any mineral of interest is fed into the jig tray **104** over jig cell #1. The flow of water across the jig tray **104** separates lighter material in the feed material from heavier material. Lighter material floats across the jig tray **104** over to jig cell #2, while heavier material sinks into the jig bed media **110** of jig cell #1, creating a more efficient jig bed at jig cell #1. Within jig cell #2, the lightest material flows out of the discharge chute **105** with the overflow, while heavier material sinks into the jig bed media **110** of jig cell #2, creating a more efficient jig bed at jig cell #2. Note that any number of jig cells can share a single jig tray **104**, or have individual and connected jig trays **104**.

At block **810**, heavy material at each jig cell that is smaller than the classifying screen **108** of the jig cell passes through the screen **108** and continues downward through the discharge tube **114** (underflow) of the respective jig cell. In some cases, the classifying screens **108** of the jig cells can be sized differently to screen different sizes of material. The heavy material, which contains a higher percentage of the mineral of interest is known as concentrates. The concentrates can be collected in a containment. Heavy material that is too big to pass through the screens **108** are trapped in the respective jig beds **110**. As more feed material is introduced, the jig trays **104** will continue to fill, trapping the heaviest material in the jig bed media **110** and rejecting the rest of the material out the discharge chute **105** at the #2 jig cell (overflow).

At block **812**, optionally, the overflow water and rejected light material can pass into a rejects containment, with the water continuing to an overflow water sump. The water in the sump can be recycled (along with fresh water if desired) by pumping it back up into the manifold **116** to be distributed to the jig cells. Water can also be allowed to drain out of the containment for the concentrates, and can be recycled as well.

The trays **104** can be cleaned out after each use to recover any oversized pieces of mined mineral (e.g., gold). Fine gold is collected and recovered in the concentrates containment.

Example Multi-Stage Mini Jig

Referring to FIGS. **9-11**, a multi-stage mini jig can be formed by the addition of a second stage mini jig **900** to the single stage mini jig **100**. An example of joining a second stage mini jig **900** to a single stage mini jig **100** is shown at FIG. **12**, and an example multi-stage mini jig **1300** is shown at FIG. **13**. Many details in FIGS. **12** and **13** are omitted for clarity. Subsequent or additional jig stages (simplex, duplex, or multiplex), such as the second stage mini jig **900** or the like, can be added to the single stage mini jig **100** or the multi-stage mini jig **1300** to form a mini jig with as many stages as desired. In some embodiments, a mini jig kit can include the components to assemble various multi-stage mini jigs in various configurations.

Referring to FIGS. **9-11**, an example second stage (i.e., subsequent stage) mini-jig **900** is illustrated. While a single jig cell configuration is illustrated, the second stage mini jig **900** can include two or more jig cells.

The operation of the second stage mini jig **900** is basically the same as the operation of the single stage mini jig **100** described above. For example, the second stage mini jig **900** includes a manifold **116*b*** where water is pumped into the one or more hutches **106*b*** and fills the hutch(es) **106*b***. Water overflowing the hutch(es) **106*b*** fills the jig tray **104*b*** and overflows out of the chute **105*b***. Feeder material for the second stage mini jig **900** comes from the discharge tube **114** (underflow) of the one or more jig cells of the stage above and is deposited in the jig tray **104*b*** of the second stage mini jig **900**.

In some embodiments, as shown at FIGS. **9-11**, the second stage mini jig **900** can include an adjustable receiver **901** that receives the underflow from the one or more jig cells of the previous (above) stage. For instance, the receiver **901** can include at least two chute-shaped receiver portions: a rear receiver portion **902** and a front receiver portion **904**, which can be pivotally coupled at a hinge connector **906**. The hinge connector **906** allows the at least two receiver portions (**902** and **904**) to be adjusted (e.g., pivoted) to receive underflow from one or more underflow tubes **114** of the stage above. The at least two receiver portions (**902** and **904**) meet with an opening between them, that allows the underflow to flow out of the receiver **901** and into the jig tray **104*b*** of the second stage mini jig **900**. Note that if the receiver is not present (for instance as shown at FIG. **17**), the underflow simply flows from the nipple **114** of the previous stage and onto the jig tray **104*b*** of the second stage mini jig **900**.

The second stage mini jig **900** is positioned below and attached to the lower portion of the single stage mini jig **100** as shown at FIG. **12** to form a multistage mini jig **1300** (shown at FIGS. **13-15**). The respective frames **101*b*** and **101** of the second stage mini jig **900** and the single stage mini jig **100**, respectively, are coupled together using removable fasteners, if desired. The receiver **901** is positioned below the one or more underflow nipples **114** of the single stage mini jig **100** to catch the underflow from the single stage mini jig **100** and distribute the underflow to the tray **104*b*** of the second stage mini jig **900**. Finally, the drive link **120*b*** of the second stage mini jig **900** is coupled to the drive link **120** of the single stage mini jig **100** to drive the rocker arm **118*b*** of the second stage mini jig **900**.

An example completed multistage mini jig **1300** is shown at FIGS. **13-15**. The jig cells are arranged in a cascading configuration and can operate concurrently. For instance, all jig cells can be driven by a single motor. Adding jig cells and stages improves efficiency, including throughput.

During operation, supply water fills the jig hutch(es) **106** of the first stage jig cells via a manifold **116** and overflows, exiting the front of the jig tray **104** at the jig chute **105** of the first stage **100**. Waste (or tailings) that is less dense than the minerals of interest can exit the first stage chute **105** with the overflow of water. A portion of the water also exits at one or more under flow openings **114** at a low portion of the diaphragm **112** directly below the hutch **106** of the first stage **100**.

Each jig tray **104** contains a screen **108** of mesh (e.g., stainless steel or the like). For instance, the screen **108** can comprise a **30**, **60**, or **100** grid mesh, depending on the screen size desired. The size of the screen **108** determines the size of the particles (e.g., minerals) that will pass through it. On the screen **108** can be disposed 3 or 4 layers (for example) of jig media, such as steel balls (e.g., ¼ inch jig shot or the like) that acts as a bedding material **110**. Feed material, or soil that contains the minerals, is placed on the bedding **110**.

The rocker arm **118** is coupled at one end to the motor **102**, via one or more drive links **120**. Each end (one or both, depending on the number of jig cells) of the rocker arm **118** is connected to a jig diaphragm **112** and the rocker arm **118** is pivotally coupled to the frame **101**. The ends of the rocker arm **118** are driven up and down as the rocker arm **118** moves in a pivoting action at approximately 300 strokes per minute (or other suitable rate) as driven by the motor **102**. The throw of the rocker arm **118** ends can be about 1.5 inches, for example, "jigging" the lower portion of the diaphragms **112** by that distance, which pushes water up and into the jig cells and the jig tray **104**, and thereby moves the hutch **106** water and bedding **110** up and down at the same frequency (e.g., about 300 strokes per minute).

The feed material (containing minerals mixed with waste) passes over the bedding **110**, and the light particles are washed and bounced out the front chute **105** of the jig tray **104** with the overflow water. Heavy or dense particles (e.g., minerals) fall into the bedding **110**, slipping between the jig shot with each up stroke of the rocker arm **118** as the bedding **110** lifts and separates, and are trapped as each down stroke sucks the bedding **110** back down and together. The heavy particles begin to slip through the screen **108** or enhance the effectiveness of the bedding **110** (if they stay trapped on the jig bed screens **108**).

As more feed material is introduced to the jig tray **104**, the densest and heaviest particles begin to displace those with less specific gravity, thus the reason for steel jig shot or like jig bedding media **110**. The heavy particles that pass through the screen **108** (i.e., concentrates) are discharged from the hutch **106** via the under flow nipple **114**. These heavy particles flow with the underflow water into the jig tray **104*b*** of the second stage, via the receiver **901** (if present).

The heavier particles that pass through the screen **108** of the first stage jig cell(s) are discharged from the hutch(es) **106** of first stage jig cells via the under flow nipples **114** and into the jig tray **104*b*** of the second stage jig cell(s). Underflow from the first stage jig cell(s) passes over the bedding **110*b*** in the tray **104*b*** of the second stage jig cell(s), and all of the lighter particles are washed and bounced out the front chute **105*b*** of the second stage jig tray **104*b*** with the overflow.

Heavy or dense particles fall into the bedding **110*b*** of the second stage jig cell, slipping between the jig media **110*b*** with each up stroke of the rocker arm **118*b*** as the bedding **110*b*** lifts and separates, and are trapped as each down stroke of the rocker arm **118***b* draws the bedding **110***b* back down and together. The heavy particles begin to slip through the screen **108***b* or enhance the effectiveness of the bedding **110***b* (if they stay trapped on the jig bed) of the second stage **900**.

As more feed material is introduced into the tray **104***b* of the second stage, the densest and heaviest particles begin to displace those with less specific gravity, thus the reason for steel jig shot or like jig bedding media **110***b*. The heavies that pass through the screen **108***b* of the second stage jig cell (i.e., concentrates) are discharged from the hutch **106***b* via the under flow nipple **114***b* of the second stage jig cell. They can be collected in a concentrates container, or can be passed to a subsequent jig stage. Each subsequent jig stage includes at least one jig cell, which operates as described relative to the second stage jig cell.

Flowchart Showing Example of Operation

Example operation of the example multi-stage mini jig **1300** shown in the embodiments of FIGS. **13-15** and **18** can be described can be described with the flow chart illustrated at FIG. **16**. Note that the example multistage mini jig **1300** shown in the embodiments of FIGS. **13-15** includes a duplex first jig stage and a single jig second stage, meaning that there are two side-by-side jig cells (jig cell **1** and jig cell **2**) at the first stage and a single jig cell at the second stage. A multistage mini jig **1300** with one jig cell or more than two jig cells in the first stage and one or more jig cells in the second stage operates in a similar manner, as described herein. Note that the example multi-stage mini jig **1300** shown in the embodiments of FIG. **18** includes a single jig cell at each of the first and second stages. A multi-stage jig with multiple jig cells in any of the stages or that has more than two stages operates in a similar manner, as described herein.

At block **1602**, water is pumped into the intake manifold **116**, which is coupled to each jig cell at the respective hutch(es) **106** and **106***b*. At block **1604**, the water fills and overflows each jig cell at each hutch **106** and **106***b*, flowing across the top of the jig trays **104** and **104***b*. At block **1606** the overflowing water flows off the discharge chutes **105** and **105***b* (see FIG. **14**, for example). Water also discharges from the bottom of each jig cell through a flow-limited discharge tube **114** and **114***b* (underflow). The underflow from the jig(s) of the first stage **100** flows into the jig tray **104***b* of the jig(s) of the second stage **900**.

As shown at FIGS. **13** and **14**, the rocker arms **118** and **118***b* are coupled to the motor **102** via a mechanical cam **122** and the drive links **120** and **120***b* that are coupled together. This causes the rocker arms **118** and **118***b* to pivot at pivot points **124** and **124***b* as the motor **102** turns. As each end of each rocker arm **118** and **118***b* rises and falls with the pivot of the rocker arms **118** and **118***b*, the diaphragms **112** and **112***b* coupled to the end(s) of the rocker arms **112** and **112***b* moves in a jigging action. The up and down jigging action of the diaphragms **112** and **112***b* under each jig cell causes the jig bed media **110** and **110***b* in each tray **104** and **104***b* to rise and fall. Each up stroke increases the upward flow of water in the respective hutch **106** and **106***b*, lifting and separating the jig bed media **110** and **110***b*. Each down stroke of the diaphragms **112** and **112***b* pulls the jig bed media **110** and **110***b* down and together.

At block **1608**, feed material (e.g., soil, etc.) bearing gold or any mineral of interest is fed into the jig tray **104** over the first stage jig cell(s). Light material floats out the discharge chute **105** with the overflow, while heavy material sinks into the jig bed **110**, creating a more efficient jig bed **110** at the first stage jig cell. At the second stage jig cell, light material flows out of the discharge chute **105***b* with the overflow, while heavy material sinks into the jig bed **110***b*, creating a more efficient jig bed **110***b* at the second stage jig cell.

At block **1610**, heavy material at each jig cell stage (known as concentrates) that is smaller than the classifying screens **108** and **108***b* passes through the screens **108** and **108***b* and continues downward through the discharge tube **114** and **114***b* (underflow) of the respective jig cell stage. The concentrates from the first stage jig cell(s) (e.g., primary) feed the second stage jig cell(s) (e.g., secondary). In some cases, the classifying screens **108** and **108***b* of the jig cell stages are sized differently. For instance, the classifying screen **108***b* in the secondary jig tray(s) **104***b* can be finer than the classifying screen **108** in the primary jig tray **104**, resulting in superfine concentrates exiting from the second stage jig cell(s).

Heavy material that is too big to pass through the screens **108** and **108***b* is trapped in the respective jig beds **110** and **110***b*. As more feed material is introduced, the jig trays **104** and **104***b* will continue to fill, trapping the heaviest material in the jig bed media **110** and **110***b* and rejecting the rest of the material out the respective discharge chutes **105** and **105***b* (overflow).

At block **1612**, optionally, the overflow water and rejected light material can pass into a rejects containment, with the water continuing to an overflow water sump. The water in the sump can be recycled (along with fresh water if desired) by pumping it back up into the manifold **116** to be distributed to the jig cells. Water can also be allowed to drain out of the containment for the concentrates, and can be recycled as well.

The trays **104** and **104***b* can be cleaned out after each use to recover any oversized pieces of mined mineral (e.g., gold). Fine gold is collected and recovered in the concentrates containment.

Interchangeability and Configurability

FIGS. **17** and **18** illustrate additional embodiments of mini jigs **100** and **1300**, respectively. In various embodiments, a mini jig arranged as a single stage mini jig **100** can be reconfigured (in the field) as a multi-stage mini jig **1300**, and vice versa. The jig cells of the respective mini jigs can be interchangeable within the respective mini jigs as well as within the various possible configurations. The support components, including the frame materials, rocker arms, fixtures, fasteners, motor, power supply, pump, and so forth can also be used in multiple configurations. Additional components, such as motor drive links, pivots, and so forth can be included in a mini jig kit for reconfigurations and additional arrangements as desired.

In an example, an associated mini trommel (washer/classifier) can also be assembled from components included in a mini jig kit or supplied separately. An example operation **1900** of a mini trommel is disclosed relative to the flow chart at FIG. **19**.

In an example, at block **1902** material is introduced to the trommel via a feed hopper located at the rear of the machine. At block **1904**, the feed hopper remains stationary while the trommel barrel rotates slowly around a center axis. In some cases, the mini trommel can be more efficient when the rear of the machine is elevated a few degrees (e.g., about 2 degrees or so). A combination of the trommel's rotation, gravity, and a constant flow of water (at block **1906**) from an internal spray bar and feed hopper spray nozzle keep the material moving slowly toward the discharge end (front) of the trommel barrel. At block **1908**, as the material is washed, smaller material passes through classifying screen windows and larger material continues forward. The larger material is discharged while the smaller, classified material is discharged below the machine.

At **1910**, most of the water is discharged through the classification screens, but some water is discharged with the rejected material out the discharge end (front) of the trommel barrel. At **1912**, the classified output of the trommel can be input as feed material to any configuration of mini jig **100** or multistage mini jig **1300**.

Aspects of the present disclosure have been described with the intent to be illustrative rather than restrictive. Alternative aspects will become apparent to those skilled in the art that do not depart from its scope. A skilled artisan may develop alternative means of implementing the aforementioned improvements without departing from the scope of the present disclosure.

It will be understood that certain features and sub-combinations are of utility and may be employed without reference to other features and sub-combinations and are contemplated within the scope of the claims. Not all steps listed or disclosed need be carried out in the specific order described.

Conclusion

Although the implementations of the disclosure have been described in language specific to structural features and/or methodological acts, it is to be understood that the implementations are not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as representative forms of implementing the claims.

What is claimed is:

1. An apparatus, comprising:

a multi-configuration portable mining machine, including:

a first jig cell having a first hutch with a discharge opening, a first classifying screen disposed within the first hutch, and a first diaphragm;

a second jig cell having a second hutch with a discharge opening, a second classifying screen disposed within the second hutch, and a second diaphragm;

a motor configured to push and pull on the first diaphragm and the second diaphragm via at least one rocker arm; and

a support frame coupled to the first jig cell, the second jig cell, and the motor, the support frame being configurable to arrange the first jig cell and the second jig cell in a first side-by-side configuration and to arrange the first jig cell and the second jig cell in a second multi-stage cascade configuration.

2. The apparatus of claim **1**, wherein the frame has a first length dimension, a first width dimension, and a first height dimension while in the first side-by-side configuration and has a second length dimension, a second width dimension, and a second height dimension while in the second multi-stage cascade configuration.

3. The apparatus of claim **2**, wherein the first height dimension is different from the second height dimension.

4. The apparatus of claim **1**, wherein the support frame is comprised of a plurality of tubes.

5. The apparatus of claim **4**, wherein the plurality of tubes includes straight tube sections, tubular elbow sections and tubular "T" sections.

6. The apparatus of claim **1**, wherein the support frame is comprised of polyvinyl chloride (PVC) tubes, joints, and elbows.

7. The apparatus of claim **1**, wherein the support frame is comprised of aluminum tubes, joints, and elbows.

8. An apparatus, comprising:

a multi-configuration portable mining machine, including:

a first stage, comprising:

a first jig cell having a first hutch with a first discharge opening, a first classifying screen disposed within the first hutch, and a first diaphragm coupled to the first hutch, the first discharge opening protruding through the first diaphragm; and

a first rocker arm arranged to alternately push and pull on the first diaphragm;

a second stage disposed below the first stage, the second stage comprising:

a second jig cell having a second hutch with a second discharge opening, a second classifying screen disposed within the second hutch, and a second diaphragm coupled to the second hutch, the second discharge opening protruding through the second diaphragm, and the first discharge opening arranged to empty into the second hutch; and

a second rocker arm arranged to alternately push and pull on the second diaphragm; and

a first drive link coupling the second rocker arm to the first rocker arm.

9. The apparatus of claim **8**, further comprising a support frame coupled to the first jig cell and the second jig cell, the support frame being configurable to arrange the first jig cell and the second jig cell from a first multi-stage cascade configuration into a second side-by-side configuration.

10. The apparatus of claim **8**, further comprising a motor coupled to the first drive link and arranged to pivot the first rocker arm and the second rocker arm.

11. The apparatus of claim **10**, further comprising a second drive link coupling the motor to the first rocker arm.

12. The apparatus of claim **8**, further comprising a third jig cell disposed side-by-side to the first jig cell at the first stage, the third jig cell having a third hutch and a third discharge opening.

13. The apparatus of claim **12**, wherein the third discharge opening is arranged to empty into the second hutch.

14. The apparatus of claim **12**, wherein the first rocker arm is arranged to alternately push and pull on a third diaphragm coupled to the third hutch.

15. The apparatus of claim **8**, further comprising a receiver disposed beneath the first discharge opening and above the second hutch, the receiver comprised of at least two chute-shaped receiver portions coupled together to allow the at least two receiver portions to be pivotally adjusted one to the other.

16. The apparatus of claim **8**, wherein a pitch of the second classifying screen is finer than a pitch of the first classifying screen.

17. An apparatus, comprising:

a multi-configuration portable mining machine, including:

a first jig cell having a first hutch with a first discharge opening, a first classifying screen disposed within the first hutch, and a first diaphragm;

a second jig cell having a second hutch with a second discharge opening, a second classifying screen disposed within the second hutch, and a second diaphragm;

a water manifold arranged to distribute water into the first hutch and into the second hutch;

a motor configured to push and pull on the first diaphragm and the second diaphragm via at least one rocker arm; and a support frame coupled to the first jig cell, the second jig cell, and the motor, the support frame being configurable to arrange the first jig cell and the second jig cell in a first side-by-side configuration and to arrange the first jig cell and the second jig cell in a second multi-stage cascade configuration.

18. The apparatus of claim **17**, wherein the first jig cell and the second jig cell are arranged in the first side-by-side configuration, and further comprising a third jig cell disposed beneath the first jig cell and the second jig cell, the third jig cell having a third hutch with a third discharge opening, a third classifying screen disposed within the third hutch, and a third diaphragm.

19. The apparatus of claim **18**, wherein the first discharge opening and the second discharge opening empty into the third hutch.

20. The apparatus of claim **19**, wherein the motor is arranged to drive the first diaphragm, the second diaphragm, and the third diaphragm via one or more drive links.

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